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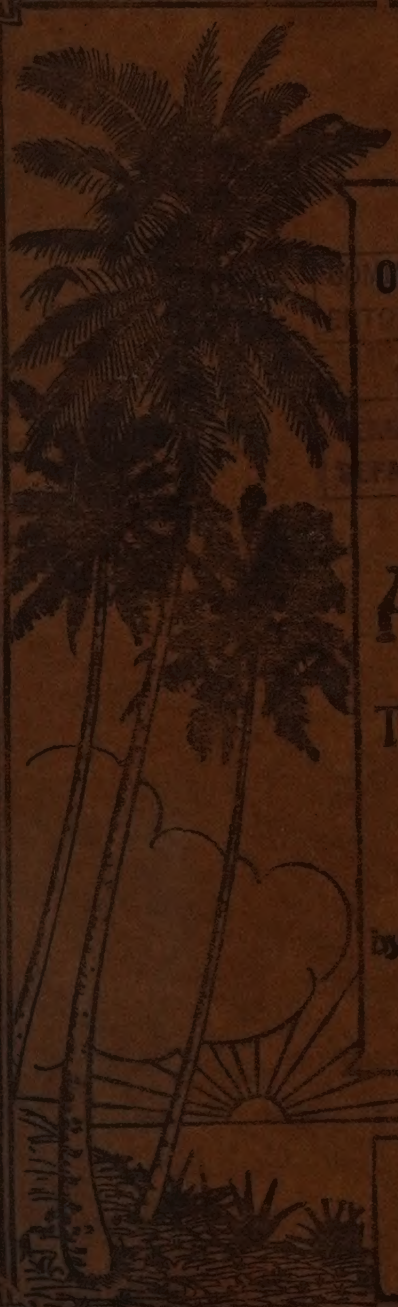

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The

Tropical Agriculturist

OCTOBER TO DECEMBER, 1948

EDITORIAL

THE MENACE OF PLANT DISEASES

WHEN large groups of one species of plant or animal are raised together under conditions differing from those in which the species occur in nature, they become liable to the attacks of parasites in an intensified form. The concentration of the parasites' food in one area frequently leads to a greater multiplication of the parasite population than would occur if the host is widely scattered. There are numerous examples of this effect. One is the increased attack of bee-hole borer in teak plantations compared to natural teak forests where the tree is scattered amongst many other species and only occurs in a density of one or two to the acre. Wherever plantations or agricultural crops are grown there is the danger of serious pests and disease breaking out in epidemic form. Though this risk has been recognized for many years it has become a more serious danger since rapid transport has made it possible to exchange planting material with distant places, whence diseases or pests new to one country may be accidentally introduced from another. Cases have occurred where a pest in its native country was not serious because it was controlled by a natural enemy, but when the accidental transfer to a new country occurred the natural predator was not included in the packet, with the result that the pest proved far worse in its new home, where sometimes physical conditions may suit it better. The planting community in Ceylon have had the danger of pests and diseases very forcibly impressed upon them and they will no doubt welcome any measures which can be adopted to lessen the risks of entry of such undesirable immigrants in the future. However strict the import regulations may be and however conscientiously they may be enforced, there will always remain some risk of an accidental introduction or one due to natural causes. That of Blister Blight on tea in 1946 was probably such a case. There is also the rare possibility of some ignorant or misguided individual evading the regulations in an attempt to introduce some supposedly superior planting material in the hope of gaining an

advantage over competitors. Attempts at such evasions are deserving of the strongest condemnation. Smuggling prohibited plants is a far worse anti-social crime than the mere dodging of customs duty on a package or two.

Ceylon is a point of call for much traffic between distant lands and recently there has been a great increase in international air traffic calling here. There is therefore reason to be particularly careful about imports of planting materials and also for control of such material which may be in transit through Ceylon. Should Ceylon unluckily become a focus of infection for any new pests or diseases (such as Swollen Shoot of cocoa or South American Leaf Disease of rubber) not only would she suffer herself but she would become a potential danger to many other eastern tropical countries.

Darlington, in a succinct letter to Nature (163, 332) recently emphasized the regrettable fact that only too often research has not been undertaken in advance of the immediate need, that when the need was not pressing it was neglected entirely or starved of funds, but that as soon as the need became urgent the scientists were expected to produce a remedy in the style of the conjurer's rabbit. It has also been neglected because often its possibilities have not been known except to a few specialists, who are not generally very vocal people. The disaster of the West African cocoa virus diseases has brought home the seriousness of such neglect from one point of view but its possibilities in promoting agricultural progress should also be recognized as well. Recently efforts have been made to ascertain whether any of the clones of Asiatic rubber show resistance to the South American Leaf Disease, a disease which has hitherto prevented the profitable growing of plantation rubber in that region, despite its being the natural home of the tree. These tests are being done at Trinidad with clonal material sent from Asia and the Ceylon Rubber Research Scheme has agreed to the testing of Ceylon-bred clones there. Some of these clones, particularly those of the NAB series, seem to be particularly promising for use in Ceylon and, while we have no immediate use for knowledge of their reactions to the South American disease, the information might be of vital importance should the disease appear in the east. Similar knowledge about Swollen Shoot diseases of cocoa would be valuable in allowing us to develop resistant clones for the replanting now going on, but naturally this information could only be obtained by tests in a country where the disease is already established. On the ground of the superiority of prevention, the breeding of resistant varieties should be regarded in the light of an insurance policy with which prudent men guard the future. It is true that every possibility cannot be foreseen and a disease or pest of insignificant importance in one country may develop serious destructiveness in a new locality. There is, nevertheless, room for the gathering together of types showing resistance which may be used for breeding purposes should the need arise. At the first meeting of the International Rice Commission in March, 1949, great importance was attached to the reporting of rice varieties which show any resistance to diseases or pests, no matter what their other characters might be, so that breeders would have an opportunity of using them in breeding programmes.

Recently a special conference was held in order to co-ordinate measures for African countries to minimize the risks of accidental introduction of pests and diseases, and another such phyto-sanitary conference was held in

Singapore to perform the same service for the countries of Asia. It is hoped that by these means the risks will be reduced by co-ordinated action.

Another feature of diseases has been the manner in which they fluctuate in severity. Often a new disease is very serious soon after its introduction and then quietens down. Such a one was the *Sphacelia* disease of Sorghum which devastated the crop in India and Burma in the early thirties and almost disappeared a few years later. Sometimes the reverse happens and it is years before a disease flares up in epidemic form. *Verticillium* wilt of hops appeared in Kent in 1924 but attracted little notice till about 1938 when it became serious and did much damage. Other diseases seem to go in cycles. Such a one is Asparagus rust which was very destructive between 1898 and 1905 and then almost disappeared only to flare up again in 1933, while another is *Didymella* wilt of tomatoes which was known in England in 1885 but did little damage till 1906 when it was epidemic for a few years, then decreased in violence only to increase again and become one of the worst diseases of the crop in 1942. The causes of these fluctuations are obscure but may depend, in part at least, on varying climatic factors of baffling complexity.

The menace of diseases is clear enough and with intensified cropping and rapid long-distance transport the risks of unwelcome exchanges are increased. The best protection would seem to lie in the two measures indicated, namely, strict legislation to control movements of plant materials, and research into the production of types resistant to known diseases.

THE INFLUENCE OF ROOTSTOCK ON GROWTH OF BUDGRAFTED CITRUS

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SUMMARY

IN budded citrus the root-stock is known to influence the growth of the scion. Symptoms of stock-scion incompatibility may appear early in the nursery beds, or may be delayed over a period of years in the orchard if the soil and climatic conditions are favourable for healthy growth of citrus.

In the mid-country semi-dry area at Malpotha all varieties of citrus grow well on rough lemon, an invigorating stock, but on the European lemon which grows to perfection at this elevation of 3,500 feet, budgrafts of sweet orange, mandarin and Seedless Tahiti lime turn chlorotic and die back in the nursery beds. The roots too die back from the tips. But the unbudded lemon seedlings and lemon budgrafts on lemon stock make healthy growth. The diseased condition is probably not due to a virus as starch is present in the pith and phloem tissues above and below the bud unions of both healthy and diseased plants.

Both grapefruit and sweet orange grow well on seedling sweet orange and rough lemon stocks at Peradeniya, but on sour orange the tendency is for the scion to become chlorotic and stunted. Buds from these chlorotic shoots produced healthy vigorous plants when budded on rough lemon and sweet orange stocks. The incidence of chlorosis and die-back on citrus budgrafts on sour orange stock appears to be delayed at Teldeniya, Moneragala and Bibile where soil and climatic conditions favour the healthy growth of citrus.

INTRODUCTION

Commercial citrus varieties in most parts of the world are propagated on a root-stock. The principal root-stocks used for the purpose are sour orange (*Citrus aurantium L.*), rough lemon (*Citrus jambhiri Lush.*), sweet orange (*Citrus sinensis Osbeck*), and trifoliate orange (*Poncirus trifoliata*).

The sour orange has been used extensively as a root-stock for citrus in the United States of America, Spain, Palestine and other Mediterranean countries. According to Hume (8) over 75 per cent. of the world's citrus was at one time on this stock because of its high degree of resistance to brown rot gummosis. In recent years, however, it has become a failure as a root-stock for citrus in South America (10), parts of California (4, 6) and Australia (3) owing to the incidence of a virus disease which causes the death of sweet orange trees propagated on it. Over 8 million trees of this stock-scion

combination are estimated to have been killed in South America since 1932 by this disease which is known there as "Tristeza", a Portuguese word meaning melancholy or sadness. Several sweet orange orchards have also gone out of production in California and Victoria since 1941 owing to the ravages of "Quick Decline" and "Bud-union Decline" which are believed to be very similar to "Tristeza" in many respects. The virus appears to continue its destructive work unchecked and is a potential menace to citrus on sour orange stock all over the world.

The rough lemon is used almost exclusively as root-stock for citrus in South Africa, parts of Australia, India, Java and Florida. Citrus varieties budgrafted on it are not affected by "Quick Decline" or "Tristeza", but it is not so resistant to brown rot gummosis as sour orange.

The sweet orange has become popular as a root-stock in place of sour orange because of its resistance to "Quick Decline", but it is susceptible to brown rot gummosis which, however, is now easy to control owing to improvement in orchard sanitation.

The use of the deciduous trifoliate orange as a root-stock is restricted to colder areas as it is inherently resistant to frost. It makes a good stock for the Satsuma mandarin which develops the best flavour on it, but with most citrus varieties stock overgrowth is very pronounced at the bud-union.

None of these citrus species makes an ideal root-stock for commercial varieties, and efforts are being made in nearly every citrus-producing country to develop suitable root-stocks for local requirements. In Ceylon the rough lemon, sour orange and sweet orange have been under trial for sometime as root-stocks (11), and more recently the sour lime (*Citrus aurantifolia*), European lemon (*Citrus limon L.*) and *Patharan* (*Citrus megaloxycarpa var. penivesiculata. Lush.*) were included for study.

EXPERIMENTAL

In the citrus stock-scion trial set down at Moneragala in November, 1945, rough lemon, sour orange and sweet orange were used as root-stocks in combination with Bibile and Vavuniya sweet orange scion varieties in a Randomized Block lay out with 4 replications and 4 plants per plot. Unbudded nucellar seedlings of the two orange varieties were also included in the trial, making a total of 128 trees.

In the root-stock trial at Peradeniya, only the Vavuniya sweet orange variety was used as unbudded nucellar seedlings and as budgrafts on rough lemon, sour orange, and sweet orange stocks in randomized single-tree plots replicated 6 times. The plants were transplanted into the permanent site from nursery beds in June, 1945.

Besides field trials several hundreds of nursery stock plants of these varieties as well as sour lime, European lemon and *Patharan* were budgrafted to Bibile and Vavuniya sweet orange, Nagpur Santra mandarin and Eureka lemon in the nurseries at Peradeniya, Bibile, Moneragala, Teldeniya, and Malpotha, and allowed to grow in nursery beds for observation.

RECORDS OF GROWTH

Measurements of girth were taken at fixed points 6 cm. above and below the bud-union. In the case of seedling plants measurements were taken 6 cm. above and below the point at which they would have been normally budgrafted.

CITRUS STOCK-SCION TRIAL AT MONERAGALA

The analysis of variance of stock and scion girth measurements recorded on September 15, 1948, is given in Appendix I. The mean values for girth are given in Table I.

TABLE I

	Stock girth in inches	*Scion girth in inches*
Rough lemon	11·30	9·57
Sweet orange	8·88	8·06
Nucellar sweet orange seedling	8·61	8·12
Sour orange	8·17	7·12

Rough lemon is significantly bigger than the others both in stock girth and its invigorating effect on the scion as reflected by scion girth. The differences in girth between the sweet orange stock, the unbudded sweet orange seedling and sour orange stock are not statistically significant, but in the stock effect on scion as measured by scion girth both sweet orange stock and the unbudded sweet orange seedling, which do not differ significantly from each other, give higher values than the sour orange.

None of these varieties has yet developed symptoms of chlorosis and die-back on the sour orange, and it remains to be seen whether they will continue to make healthy growth on this stock at Moneragala.

ROOT-STOCK TRIAL AT PERADENIYA

Measurements of stock and scion diameters were taken on September 10, 1948. The mean values are given in Table II and the analysis of variance in Appendix II.

TABLE II

	Stock Diameter in Cm.	*Scion Diameter in Cm.*
Rough lemon	8·17	6·53
Sweet orange	5·80	5·05
Nucellar sweet orange seedling	5·60	4·92
Sour orange	3·40	3·15

The rough lemon is again significantly bigger than the others both in stock diameter and in scion diameter. The differences between sweet orange stock and the unbudded nucellar sweet orange seedling are not statistically significant as may be expected, but the sour orange gives significantly lower values than the others for both stock diameter and scion diameter. Most of the plants on the sour orange stock were stunted and chlorotic, a few were already dead in the border rows.

NURSERY TRIALS

In nearly every case the growth of sweet orange on rough lemon was vigorous and healthy. Hardly any symptoms of chlorosis developed on the plants in the nursery or in the field trials. The growth of the sweet orange varieties on sweet orange stocks was also normal both in the nursery and the field. Even all the varieties of grapefruit—Marsh seedless Thomson, seedless, Cecily seedless, Walters, Ellen, Foster McCarthy and Triumph budgrafted on sweet orange in the grapefruit stock-scion trial at Peradeniya continued to make healthy growth.

Plate 1.—Six year old Marsh Seedless grapefruit on sour orange stock at Peradeniya. Note unhealthy stunted growth and die-back of the twigs.

But on the sour orange stocks in the nursery at Peradeniya the growth of sweet orange and grapefruit was variable. Most of the plants developed symptoms of chlorosis and mottle leaf with the first flush and showed a tendency to remain stunted. Some flowered and set fruit prematurely in the nursery beds. Those that remained healthy grew well only for about a year or two when planted out in the field (Plate 1). The incidence of chlorosis was however not very general in the nurseries at Teldeniya, Moneragala and Bibile where soil and climatic conditions appear to favour the healthy growth of citrus. Nevertheless, when the apparently healthy plants were planted out in the field at Teldeniya for observation, nearly all of them developed symptoms of chlorosis and died back within three to four years. Budgrafts of the same varieties on rough lemon stock inter-planted in the same area continued to make healthy growth and were very productive. Several grapefruit trees on sour orange stock in the stock-scion trial at Hingurakgoda are also considerably dwarfed and show characteristic scion over-growth although they continue to survive.

Sour lime seedlings were tried as root-stocks for sweet orange in the nurseries at Bibile and Moneragala as they are easy to raise in very large numbers and exhibit appreciable resistance to drought. Most of them were successfully budded to Bibile and Vavuniya sweet orange, but after the tops were cut off to force the scion buds the bark opposite the bud patch began to die-back from the cut end. In many cases the die-back was presumably arrested by the growth of the scion which helped to stimulate callus formation along the margins of the bark bordering the dead surface. No such die-back was to be seen on comparable rough lemon and sweet orange stocks budded in the adjoining nursery beds.

Seedlings of the European lemon which grows well up-country were interplanted with rough lemon stocks in nursery beds at Malpotha which is about 3,500 feet above sea level and budded separately to Washington Navel orange, Nagpur Santra mandarin and Eureka lemon. Growth of all the varieties was normal on the rough lemon, but on the lemon stocks only Eureka lemon made normal vigorous growth. The first flush produced by the sweet orange and mandarin buds turned chlorotic and died back after shedding the leaves (Plate 2). Examination of the root systems showed progressive dying back of the tap roots and laterals from the tips. The bark was sloughing off from the dead portions of the roots which were discoloured bluish grey. The unbudded lemon seedlings also made normal growth like the lemon budgrafts and showed no die-back of the roots.

The Patharan is also reputed to be drought resistant like the rough lemon which has a fibrous root system, but it is difficult to transplant successfully from nursery beds after budgrafting as it has a long tap-root with hardly any laterals. The scion buds of the common citrus varieties do not "take" readily on it owing to the copious flow of gum from the exposed tissues during long dry spells. Nevertheless, trees of Marsh seedless and Walters grapefruit on this stock planted ten years ago on rocky land in the semi-dry zone at Nalanda have grown well without irrigation and are very productive. Other citrus varieties have been raised on this stock for trial next season.

BUDGRAFTING TRIALS

Buds were taken from the chlorotic shoots of Vavuniya sweet orange on sour orange stock and from the healthy shoots of the same variety on rough

lemon and sweet orange in the trial at Peradeniya, and budded on sour orange, rough lemon and sweet orange stocks in a nursery nearby. The growth of all the buds including those from the chlorotic shoots was normal and of healthy green colour on all the stocks except sour orange on which scion growth continued to be chlorotic and sickly.

Similarly, chlorotic buds from Washington Navel orange grafts on European lemon stocks at Malpotha were found to make healthy growth when inserted on rough lemon stocks.

DISCUSSION

From the studies made so far it appears that even the local varieties of sweet orange such as Bibile and Vavuniya, which are of seedling origin and inherently more vigorous than many of the imported varieties, make unhealthy growth on the sour orange, and that the incidence of chlorotic symptoms on plants of this stock-scion combination is delayed in areas where soil and climatic conditions are favourable for healthy growth of citrus. The symptoms appear earlier in the wet zone at Peradeniya where even seedling citrus trees tend to become chlorotic within a short period if neglected.

The failure of the sweet orange on sour orange stock was first observed in South Africa as far back as 1899 (14). The stock would, however, make healthy growth and bear normal crop if allowed to grow unbudded, and so would the commercial lemon budgrafted on it. But sweet orange and, to a less extent, grapefruit and mandarin would fail to grow into healthy trees when budgrafted on it. The trees either died quickly in the nursery or within a short period after planting out. Those that survived were much dwarfed and worthless as producers. The failure was described as stock-scion incompatibility. The commercial lemon, certain acid limes, and to some extent the grapefruit, were also found to behave more or less like the sour orange when used as root-stocks.

Similar stock-scion incompatibility was observed in Java by Toxopeus (13) who thought that the sweet orange scion produced some substance which was toxic to the sour orange stock. Oberholzer (9) has now shown that a virus is probably responsible for the failure of sour orange as a root stock in South Africa. He first produced healthy budgrafts of Valencia orange and Triumph grapefruit on sour orange and lemon stocks by using budwood from seedlings of nucellar origin which are believed to be vigorous and free from virus infection. These seedlings come true to type since they develop from vegetative buds of the nucellus which consists only of maternal tissue. The healthy budgrafts were found to stop growth and develop chlorotic symptoms when buds of the same scion varieties taken from apparently healthy budded trees in the orchard were inserted into the root-stock or the scion. The virus seems to have been able to maintain itself in the sweet orange trees on rough lemon and sweet orange stocks in the orchard without showing any characteristic symptoms.

Similar transmission experiments have been carried out in California by Fawcett and Wallace (7) who showed that sweet orange trees on sweet orange stocks could become infected in the orchard and serve as carriers of virus in a latent form while remaining symptomless. McAlpin *et al.* (3) working in Victoria, Australia, have also found that buds from healthy

Plate 2.—Citrus budgrafts on European lemon stock at Malpotha nursery. Note vigorous growth of Eureka lemon (second from left) and unhealthy growth of Washington Naval orange (Extreme right) and Nagpur Santra mandarin.

Washington Navel tree on rough lemon developed symptoms of "bud-union decline" when worked on sour orange stock, but gave healthy trees on sweet orange stock.

The theory originally stated by Bitancourt (1) and elaborated by Webber (15) is that the virus could be present in sweet orange, mandarin and grapefruit without showing characteristic symptoms, but its action and development in the unbudded sour orange or lemon is probably inhibited by some product of metabolism in the foliage. That accounts for the healthy growth of the unbudded plants as well as suckers from the root-stock of budgrafts. But when used as a root-stock without its own foliage the virus from the infected sweet orange top is believed to cause the break-down of the sour orange sieve tubes below the bud-union.

Schneider (12) has shown by histological studies that degeneration of the sieve tubes occurs in the bark of the sour orange stock just at or below the bud-union as a result of which the translocation of starch to the roots is apparently restricted and the roots are starved after they use up the reserve food. This causes a progressive die-back of the roots from the tip towards the base.

The starch disappears almost completely from the roots of trees which are about to develop symptoms of "Quick Decline" (5) or "Bud-Union Decline" (3). First the bark and later the wood of the rootlets become devoid of starch which then disappears all along the large roots from the tip to the base. In acute cases the entire root-stock is depleted of starch right up to the bud-union. The loss of starch from roots of citrus is not usually associated with fungus and bacterial diseases or nematode attack.

The starch content of the bark and the wood above the bud-union may remain normal or even higher than that of the healthy trees. Nevertheless, very often trees which have been on the decline for some period and have reached a stage of unthrifty equilibrium may show approximately normal starch content in the root-stock. The starch test is therefore not always reliable in such cases.

The presence of starch is easily demonstrated by application of aqueous solution of iodine with a camel hair brush on the lightly scraped bark or wood. Any tissue containing starch will turn blue or even black according to the amount present. It has been shown by Cameron (2) that starch is present at all times in the wood of healthy citrus roots.

All citrus plants on rough lemon and sweet orange stocks in the nursery and field trials at Peradeniya and elsewhere were found to contain starch in the bark and wood both above and below the bud-union. But some of the grapefruit plants on sour orange stock in the nursery at Peradeniya were found to be devoid of starch below the bud-union although the root system consisted of a long well developed tap-root and several laterals (Plate 3). Nevertheless, in many Vavuniya sweet orange grafts on sour orange stocks which had remained stunted and chlorotic for about 2 years in the nursery at Peradeniya, starch was found to be present in the wood of the main taproot.

Starch was also present both above and below the bud-union of many chlorotic Washington Navel and Nagpur Santra mandarin plants on commercial lemon stock at Malpotha. There were, however, some healthy lemon

plants in active state of growth which contained no starch in the roots. Preliminary examination of sections of bark and wood above and below the bud-union has not shown any characteristic symptoms of break-down of phloem tissues, and the evidence available so far is not sufficiently conclusive to prove that the failure of sweet orange, grapefruit aud mandarin on sour orange and commercial lemon in most parts of the Island is due to a virus. Further investigations are being made in collaboration with the Plant Pathologist.

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Plate 3.—Rough lemon stock budded to Marsh Seedless grapefruit on left shows presence of starch in root and stem portion below bud union when treated with iodine, but sour orange stock budded to same variety of grapefruit is devoid of starch.

APPENDIX I

Citrus Stock-Scion Trial—Moneragala

Analysis of Variance of Stock Girth Measurements

	DF	*SS*	*Variance*	*F*	*1 per cent. point*
Blocks	3	25·89	8·63	5·20	4·87
Treatment	7	75·02	10·72	6·46	3·65
Error	21	34·96	1·66		
Total	31	135·87			

Significant difference = ·91 inches

Analysis of Variance of Scion Girth Measurements

	DF	*SS*	*Variance*	*F*	*1 per cent. point*
Blocks	3	19·48	6·49	4·08	4·87
Treatment	7	53·99	7·71	4·85	3·65
Error	21	33·32	1·59		
Total	31	106·79			

Significant difference = ·89 inches

APPENDIX II

Citrus Stock-Scion Trial—Peradeniya

Analysis of Variance of Stock Diameter Measurements

	DF	*SS*	*Variance*	*F*	*1 per cent. point*
Blocks	5	·59	·118	·118	—
Treatment	3	68·33	22·78	22·78	5·42
Error	15	15·02	1·00		
Total	23	83·94			

Significant difference = ·85 cm.

Analysis of Variance of Scion Diameter Measurements

	DF	*SS*	*Variance*	*F*	*1 per cent. point*
Blocks	5	1·66	·332	·163	—
Treatment	3	34·52	11·51	5·64	5·42
Error	15	30·64	2·04		
Total	23	66·82			

Significant difference = 1·21 cm.

MODIFICATION OF NEWCASTLE DISEASE (RANIKHET) VIRUS*

BY

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SUMMARY

THE work herein described deals chiefly with the method and procedure adopted in the modification of Newcastle disease virus of Philippine strain under laboratory conditions. From the limited data gathered, the following important observations and findings are derived :—

(1) The behaviour of the virus in ducklings injected intracerebrally and the response of fowls injected with the brain material of the corresponding passages are in general agreement in the different series.

(2) Nervous and digestive symptoms in the test ducklings were consistently observed in all the passages while the temperature reaction was only up to 5th passage in each series.

(3) Beginning with the sixth intracerebral duckling passage, the virus became apathogenic to test fowls.

(4) Fowls injected with brain material from the 6th to 8th duckling passages were immune to 10,000 m. l. ds of potent virus.

(5) This loss of virulence appeared to be due to a real modification of the virus and not to the diminution in its amount as shown by the virus titre of the brain and infectivity test of the different organs tested.

Based on these limited observations, it may be tentatively maintained that six intracerebral passages of Newcastle virus, Philippine strain, in young ducklings modified the virus so as to become apathogenic to fowls and that virus so modified induced immunity in them.

INTRODUCTION

Recognition of a disease of poultry, generally termed Newcastle disease, for the first time in the Dutch East Indies and in Newcastle-on-Tyne (England) in 1926, led in the subsequent years to detailed study of its epizootiology, symptomatology and comparative pathology and the isolation and identification of its causative agent. The work on successful

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Work done in the laboratories of the Bureau of Animal Industry, Manila, from July, 1947, to March, 1948, and presented for graduation for the degree of Doctor of Veterinary Medicine at the College of Veterinary Science, University of the Philippines, Manila.

immunization has, however, been scanty. Numerous efforts to develop a satisfactory method of attenuating the virus to produce active immunization against this highly infectious and destructive disease of fowls and other birds have either failed or given unsatisfactory results, not only in the Philippines but also in other parts of the world where this disease is prevalent. Various research workers adopted a number of procedures of attenuation or inactivating the virus which resulted in either insufficient attenuation or complete denaturation. At the suggestion of Dr. A. B. Coronel of the Veterinary Research Division, Bureau of Animal Industry, Manila, Philippines, experiments were performed with the object of finding out whether Newcastle disease virus of the Philippine strain could be modified by intracerebral passages in ducklings of tender age and whether the product obtained by such modification is capable of producing active immunity in fowls.

REVIEW OF LITERATURE

It would be useful here to review briefly the findings of previous workers on the subject under discussion.

Iyer and Dobson [6] reported for the first time the successful modification of Newcastle virus (Herefordshire strain) by serial passages in embroyonating hen eggs. After 33 egg passages in one series and 14 in another, the virus became virtually apathogenic for fowls, yet produced an immunity adequate to protect against a challenge with 10^{8} m.l.ds of virus given 14 to 17 days later. The virus, however, was not altered in its pathogenicity for embryos after 58 passages during a period of two years. Attempts made by Topacio and Coronel [7] to adapt Newcastle virus in laboratory animals were not met with much success. Generoso, *et al.*[4], in their first attempt at crop virus inoculation into fowl, duck and turkey embryos found that only one turkey embryo died in 72 hours after being inoculated. From this dead embryo, passages were made to turkey embryos until the tenth generation and it was found that its quickest embryo-killing ability, reached on the second generation, could not be increased any more by successive transfers. A 10 per cent. suspension of the turkey embryo after the third transfer was found infective to duck and fowl embryos. Passages of the virus in the embryos of these two species were made up to the tenth generation and it was found that the highest killing ability of the virus content in each species of embryos when tested on White Leghorn fowls, was 1 cc. of a $2(10^{-10})$dilution. Acevedo and Mendoza [1] were not able to alter the virulence of the Newcastle disease virus either in 9-day old fowl embryos or in duck and turkey embryos passed up to the fiftieth passage. However, by adopting another method utilizing the amniotic fluid, the allantoic membrane and the embryo proper, emulsified in equal volume of glycerinated phosphate buffer solution and attenuated by adding 1 : 2000 (0·05%) crystal violet and 0·05% of formalin or 0·7% sodium borate and 0·1% formalin, and stored for ten days in an ordinary ice box, the virus was modified so as to produce a protective vaccine. Coronel [3] who did exhaustive work in the attenuation of the virus by adaptation to particular tissues or hosts, by ageing of the virus suspended in phosphate buffers for varying periods, by desiccation and by chemical treatment was successful only in the chemical method of attenuation using alumina gel as an inactivating agent. When this vaccine was injected, the virus particles were released

gradually from the colloidal particles in subinfective doses, inducing the necessary antibody response (immunity) without causing any visible clinical manifestations. Brandly, Moses, *et al.*[2] observed, by their several studies on the immunization of fowls, that the nature of immunity derived from the inactivated virus vaccine, even when fortified with certain adjuvants, definitely limited their usefulness. They also observed that the high stability and tenacity of a number of strains of Newcastle virus was affirmed by lack of demonstrable changes in pathogenicity and immunogenicity during continued serial passages in embryonating eggs. They also showed that inactivation by formalin appeared to have an advantage over killing the virus by ultraviolet irradiation and that the former method was economical and provided a greater margin of safety as regards denaturation. In India, Haddow and Idnani[5] observed modification of the virulence of Newcastle virus from the allanto-amniotic fluid when absorbed in alumina gel. Such a vaccine gave solid immunity for 5 months to all adult fowls. They also fixed the virus in pigeons using strain R 10 and after the 101st to 180th passage in pigeons, the virus gave clear indication of the degradation in virulence. They continued the passage of pigeon-passed virus in duck eggs. At the tenth passage it was slightly attenuated for fowls, but continued (up to 50) passages produced no further noticeable attenuation. They then considered that the passage in very young ducklings might be more effective. Three seperate attempts were made in ducklings, one to ten days old, two with virus already frequently passaged in duck eggs, and one with stock R 1 strain. All these three attempts gave more or less similar results. Firstly, they found that though such ducklings react, not all of them die. They were unable to go beyond the fifth duckling passage, at which stage the virus had become markedly attenuated for fowls and also grew very slowly in embryos which survived for 3 to 7 days. In the latter case, normal growth and embryo-killing powers were recovered after two or three hen egg passages but the virulence for fowls did not return. It was also reported by Brandly, *et al.*[2] that Komarov and Goldschmid were unable to change the virulence of the Newcastle virus for fowls by nine intra-cerebral passages in pigeons but found that after eight passages by this route in ducklings the virus was largely apathogenic for, and produced a substantial specific immunity in fowls. No other details of the experiment, however, are available.

MATERIALS AND METHODS

A freshly isolated field strain of virus kept in egg culture was used as the inoculum. Susceptible fowls are country-bred, White Leghorn birds, 3-8 months old and apparently free from disease. They were kept isolated and treated for internal parasites whenever they were found to be affected. The ducklings were one to twenty days old when used. The fertile eggs supplied were from imported and locally raised pure bred fowls. Only those eggs with vigorous viable embryos as shown by candling were utilized.

The experiments were conducted on the following lines :—

(1) The virus was injected intracerebrally into ducklings 1-20 days old. In the first passage, 0·1 cc. of the egg cultured virus was used as the inoculum. Subsequent passages were made by making 10 per cent. emulsion of the brain tissue of the ducklings which either died or were sacrificed at the height of the disease and 0·1 cc. of it was injected through the same route.

(2) With each passage in the duckling, a cross test was made, whenever possible, on susceptible fowls, to ascertain at what duckling passage the virus became apathogenic for fowls.

(3) Each passage inoculation was done on one or two ducklings. In the latter case, one was killed at the height of the febrile reaction and the other allowed to die and the brain material of both collected and passed again in the same manner as in (1).

(4) The fowls surviving the injection of the duck brain passed virus were tested for immunity using 10,000 m.l.ds of virulent virus as test dose.

(5) Tests were also carried out to determine whether solid organs such as lungs, liver, spleen and kidney of ducklings were infective to fowls at certain passages, specially at the stage when the brain material is apathogenic for them. If not infective, the test fowls were tested for immunity as in (4).

(6) The virus titre of some passages was obtained by inoculating 9-10 days old chick embryos with serial dilution of the duck brain emulsion.

EXPERIMENTS

Experiment I.

The virus used consisted of a recently collected embryonic fluid of artificially infected fowl embryos. Two ducklings were given intracerebral injections of 0·1 cc. of the material using a 25 gauge, $\frac{1}{4}''$ needle attached to a one cc. tuberculin syringe. The seat of injection in the duckling was prepared thus : The feathers over a small space on the cranium of the duckling were pulled out and the exposed scalp was disinfected with tincture of iodine. The needle was inserted with extreme caution at a point right or left of the central cranial suture and 0·1 cc. of the virus in the syringe was released. Two days after injection, the ducklings started to show symptoms of irritability and general malaise. On the evening of the third day, they manifested marked unsteadiness of gait, discharges from the nostrils and eyes and profuse diarrhoea with mucus. There was complete loss of appetite. On the fourth day, paralysis set in and as it progressed symptoms of laboured breathing, increased lachrimation and nasal discharge were noted. The temperature which rose up to 108°F. on the second day after injection came down to 98°F. on the fourth day. At this stage, one of the duckling (No. 1B) was sacrificed and its brain collected aseptically. A portion of the brain placed in a white 25 cc. bottle containing glass beads was weighed, the bottle stoppered and shaken to grind the brain tissue. The necessary quantity of physiological saline was added to make a 10 per cent. suspension and the bottle again shaken to make a good emulsion. One tenth cubic centimeter of the latter was injected into duckling No. 2B to constitute one part of the second passage. The other duckling of the first passage was allowed to die and its brain was also collected aseptically and a 10 per cent. emulsion of it was similarly made and injected into another duckling to constitute the other part of the second passage. The course, temperature, reaction and symptoms of the disease as noted and recorded were practically the same as in the duckling which was sacrificed. This series was continued to the seventh passage using the same number of ducklings as in passage No. 1 and No. 2 except in the seventh, in which three ducklings were used. The test ducklings of these later passages

were allowed to die except one in the seventh passage, which was sacrificed at the height of the disease. The course, symptoms and thermal reaction were also noted and recorded. The results of this experiment are summarized in Table 1. (All tables are shown at the end).

Experiment II

In the second experiment, the same technique was used as in the first. The number of ducklings used in various passages and the number of passages in which the brain material was tested on fowls, however, varied. Freshly collected embryonic fluid was also used as the inoculum. Two ducklings were injected in the first passage. In the subsequent passages up to and including the fourth passage, only one duckling for each passage was used, while from the fifth up to the tenth passage, two ducklings were injected in each case, one of which was killed at the height of the disease and the other allowed to die. In the tenth passage, only one duckling was injected. As usual the brain material for cerebral injection was obtained from a duckling of the immediately preceding passage, but in the fifth, the material was obtained from duckling No. 4A of the fourth serial passage. This series was continued up to the tenth passage. The results obtained in this series are summarized in Table 2. Infectivity of the brain of each duckling passage was tested on fowls and the results are summarized in Table No. 3.

Experiment III.

The third experiment was conducted in exactly the same manner as the foregoing experiments with the following modification: one duckling was used for intracerebral inoculation in the 1st, 4th, 8th, 9th and 10th passages, while in the rest of the serial, two ducklings were utilized. Brain material of the 8th duckling passage was not tested for infectivity for fowl, Results obtained in this series are the same as in experiment II and are discussed elsewhere. Infectivity of the brain of each duckling passage was tested on fowls and surviving birds were tested for immunity.

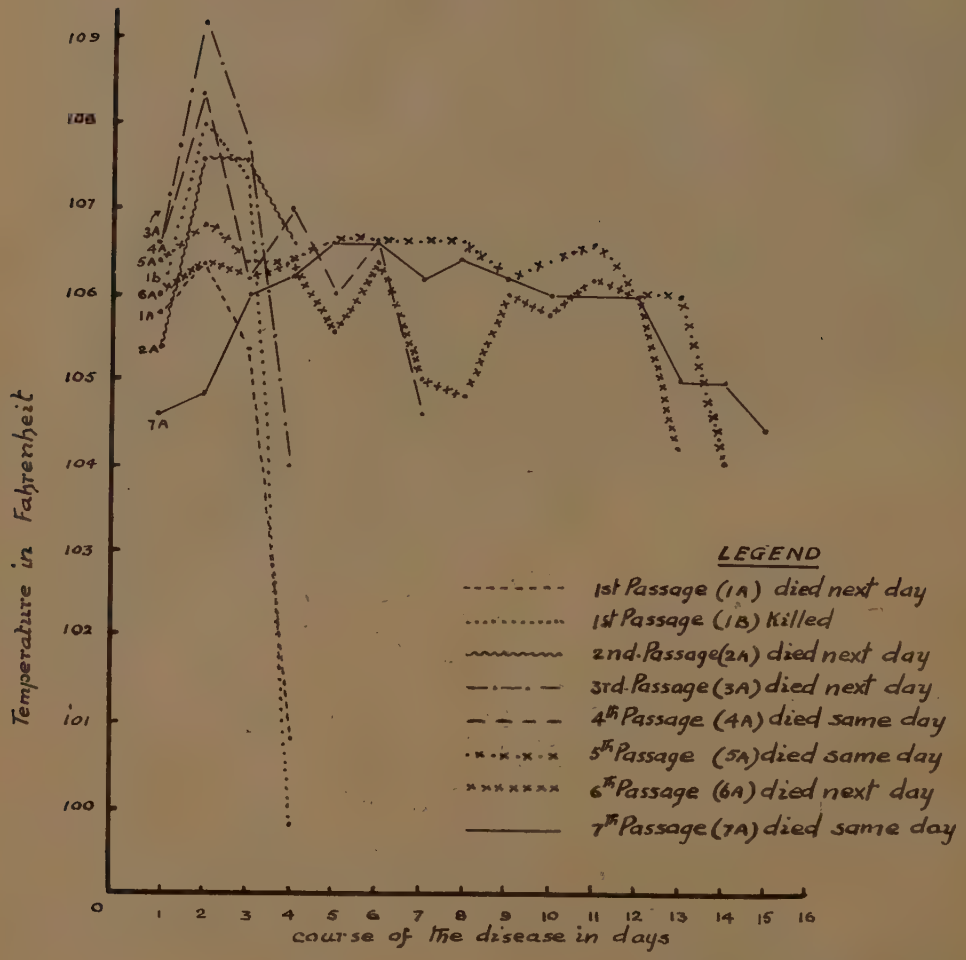
Experiment IV.

In this experiment the same procedure was followed as in the previous experiments except that a more detailed study was made to find out how the brain material obtained from a duckling killed at the height of the disease behaved in comparison to the brain material of the same passage obtained from a duckling allowed to die of the disease. This was carried out in the 1st, 2nd, 4th, 5th and 6th passages but not in the 3rd and 7th due to unavoidable circumstances. This deficiency, however, was made up by the work already done corresponding to these passages in the previous experiment. As in the previous experiment, infectivity of the brain of each duckling passage was tested on fowls and the surviving birds were tested for immunity.

Experiment V.

In experiment I it has been found that the virus was modified in its virulence for fowls at the sixth duckling intracerebral passage. Is this

Chart showing temperature reaction and course of disease in ducklings of serial passages.



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degradation a real modification of the virus or is it simply due to a diminution in the amount of virus present in the tissues, as ducklings used are not its natural host ? In an attempt to settle this point, subsidiary experiments were conducted simultaneously with those in connection with the determination of the behaviour of the virus in the different duckling passages.

For this purpose, the internal organs—liver, spleen, lungs and kidneys—of ducklings of passages No. 4, No. 5 and No. 6 of experiment IV were aseptically collected and ground separately as in the case of brain. One cubic centimeter of each emulsion was injected intramuscularly into each susceptible test fowl. When a sufficient number of test birds were not available, the spleen, kidney and lungs from one duckling passage were pooled together and tested. As in the previous experiments, all birds surviving the injections were tested for immunity. Results are shown in Table No. 4.

Experiment VI.

The virus titre of the brain of the 1st and 6th duckling passages of experiment I, were determined using the egg-technique, while in Experiment IV, virus titre of the 1st, 5th and 6th passages were also tested by the same technique using the following dilutions : 10^{2}, 10^{3}, 10^{6}, $5(10^{6})$, 10^{7}, 10^{8}, in all cases. Lesions in embryos and the number of days, (5), during which death took place were taken as the criteria of death due to virus infection. Results of the titration are shown in Tables Nos. 5 and 6.

DISCUSSION OF RESULTS

From the results of the first experiment (*vide* Table I) it would appear that the behaviour of the virus from the first to the fourth passage is practically the same, causing in the ducklings more or less identical symptoms in every passage; although the incubation period and course of the disease had a tendency to become protracted; but from the fifth to the seventh passage, although the symptoms were essentially the same, the incubation period and the course were definitely prolonged. The virus also gave rise to increase in body temperature in the first four passages (see representative temperature chart), while in the subsequent ones it did not produce marked thermal reaction except in the seventh passage when the temperature was appreciably high, which, however, cannot be accounted for.

Since this experiment was preliminary in nature and as test fowls were not available, it was only in the sixth and seventh passages that the virulence of the virus of the brain of ducklings was tested on susceptible fowls. One fowl, A 1, was injected with 1 cc. of 1 per cent. brain emulsion of the sixth duckling passage, while another, A2, was given 1 cc. of a 10 per cent. emulsion of the brain of the seventh duckling passage. Both the test fowls did not show any apparent symptoms of the disease. After an interval of 18 and 20 days respectively following the brain emulsion injection, these fowls were given 10,000 m.l.ds of virulent virus, and both showed slight rise of temperature for two days only. Unfortunately one of them, A 1, died four days after virus inoculation due to heavy worm infestation. The other fowl, A2, however, remained immune.

These results show that the six intracerebral passage of Newcastle virus in duckling attenuated the virus so as to become apathogenic to fowls and that the fowls so injected proved to be immune to subsequent virulent virus inoculation.

In the second experiment, as shown in Table 2, the results were practically the same as those obtained in experiment I; that is, the virus caused practically the same symptoms in ducklings and it became apathogenic to fowls beginning from the sixth passage. There was, however, a variation in regard to the course of the disease from the sixth to ninth passages when it became shorter compared with that of the corresponding passages in experiment I. As shown in Table 2, the virus, from the first to the fifth duckling passages, caused infection and death in all the test fowls. Fowls which survived after the brain tissue injections were later tested for immunity by giving them 10,000 m.l.ds. of virulent virus. The duckling brain passed virus from the sixth to the ninth passage was no longer infective to fowls but induced immunity in them, except the one of the ninth passage. Whether the failure was due to non-antigenicity of the virus obtained beyond the eighth passage or a lack of response on the part of the test fowls cannot, however, be ascertained. Work, therefore, on this line is indicated.

In the third experiment, the behaviour of the virus remained practically the same as observed in experiments I and II in so far as the symptoms it induced in ducklings were concerned. The course of the disease varied somewhat, but in general is in agreement with the fact that as the number of passages increases the course of the disease becomes protracted. The results of the infectivity test of the duckling-brain passed virus were disappointing, as fowls of doubtful susceptibility happened to be used from the first to the fifth passages and consequently they did not come down with the disease as those in experiment II. Test fowls of known susceptibility were, however, used in testing the infectivity of sixth and seventh duckling passages, the results of which were similar to those of the corresponding passages in experiment II, that is, the virus became apathogenic to fowls and induced immunity in them. No further duckling passage in this series was tested on fowls.

In general, the results obtained in the fourth experiment, conform with those obtained in the preceding experiments; that is, (1) the virus caused more or less similar symptoms in ducklings, (2) the course of the disease varied somewhat although on the whole it had a tendency to become longer as the number of passages increased except for the 8th passage of this series, which happened to be too short, (3) that the brain-passed virus remained infective to fowls up to and including the fifth passage, except for that obtained from 4A and 5A ducklings of the fourth and fifth passages which were allowed to die, where the brain material neither caused infection nor induced immunity, (4) the virus became apathogenic to fowls after six intracerebral passages in ducklings.

Except for test fowls injected with brain of ducklings 4A and 5A all the surviving test fowls were protected against an injection on 10,000 m.l.ds of virulent virus.

Results obtained from the work carried out by injecting the solid internal organs of test ducklings of experiment No. 4 on susceptible birds

and immunity tests on surviving birds, showed that only the liver and spleen of test ducklings of the fourth passage were infective. The lungs and kidneys of this duckling passage as well as all the organs in passages No. 5 and No. 6 were non-infective, and did not induce immunity, while the corresponding brains of these passages as shown in experiment IV were infective to the fifth passage, thus showing that the virus has become concentrated or fixed in the brain tissue. In other words, it has become more or less neurotropic and has, therefore, been modified.

From the results of the titration of duckling brain-passed Newcastle virus from Experiments No. I and No. IV, it can be seen that the virus in the first passage in experiment I killed the embryos within three days at 10^2 dilution, while in the sixth passage it killed the embryos within five days even at the highest dilution of 10^8.

The virus of the first passage in experiment IV killed one of the embryos at 10^2 dilution and both embryos at 10^3 dilution within three days; at fifth passage it killed the embryos within eight days at 10^2 to 10^7 dilutions and one of the embryos at 10^8 dilution. At the sixth passage, the virus obtained from the duckling sacrificed at the height of the disease killed all the embryos within five days at 10^2 to 10^8 dilutions except one embryo at 10^7 dilution which died after the eighth day, while that obtained from duckling allowed to die, killed one embryo at 10^2, and both embryos at 10^3 within two days, one embryo at 10^6 and both embryos at 5 (10^6) and one embryo at 10^7 dilutions within 3 days and both the embryos at 10^8 dilutions within 6 days.

GENERAL DISCUSSION

With but slight variations, the results of the first four experiments are in general agreement as regards the behaviour of the virus in ducklings injected intracerebrally and in the response of fowls injected with the brain material of the corresponding passages in the different series. It will be noted that nervous manifestation in the form of excitability, twitching or shaking of the head and droopiness as well as thermal reaction, which were marked up to the 5th passage in each series, were consistently observed.

It will also be noted that loss of virulence for fowls started with the 6th duckling intracerebral passage in each series. This degradation of the virus appears to be a real modification as shown by the results of experiments V and VI. In experiment V where the internal organs, except the brain, was tested for the presence of the virus, only the liver and spleen of the 4th passage of experiment No. 4 were positive. Beyond this passage, tests for virus were negative except for the brain of the corresponding passages (as observed in experiment IV), tending to show that the affinity of the virus to the nervous tissue has become definite, that is, it has been modified into a neurotropic type of virus.

That the modification of the virus is real and is not due to a diminution in the amount of virus contained in the brain is borne out by the results of the titration of virus contents of the brain materials of the different passages shown in Tables 5 and 6. Although the results vary somewhat in details, in general, they agree in establishing the fact that in the first passages of both series, the virus killed only in high concentration but not in high dilutions

while in the sixth passage, the virus killed embryos in both high concentration and high dilutions, tending to show that it has become adapted to the nervous tissue and multiply there in high proportion. This is in support of the theory that modification is real and not due to a dimunition in the amount of the virus. Because of the fact that the internal organs of ducklings injected intracerebrally do not possess antigenic properties, they cannot be used for immunization purpose. The brain containing the modified virus, therefore, is the only organ that can be utilized. As the highest dilution of the brain that had proved to be protective so far is only 1 : 10, it is worth while finding out the highest dilution that could induce immunity. If it proves to be protective at higher dilutions, then the production of modified Newcastle virus for vaccine purpose would be practical. For lack of time, no work as to how long the immunity it induces in fowls will last was done and also no experiment was performed to find out whether the modified virus will revert to its original virulence.

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TABLE 1.—The behaviour of Newcastle virus in serial intracerebral duckling passage

Passage No.	*Duckling No.*	*Course of disease in days*	*Symptoms observed*	*Termination*
First	1 A	5	2 days after injection—Temperature 106·4°F. and malaise. 3rd day—diarrhoea, nasal and lachrimal discharges; 4th day completely prostrate. Paralysis progressed till death	Died
	1 B	4	2nd day—Temperature 108°F. Other symptoms, same as above. Killed when paralysis set in	Killed
Second	2 A	4	2nd day—Temperature 107·6°F. 3rd day—unsteady gait, head drooping. 4th day—diarrhoea and nasal discharges profuse and death	Died
	2 B	2	2nd day—Temperature 108·4°F. 3rd day—malaise and died all of a sudden. (No passage made)	Died
Third	3 A	4	2nd day—Temperature 109·2°F. 3rd day—unsteady gait. 4th day—marked nervous irritability, diarrhoea. By evening, marked paralysis	Died
	3 B	6	2nd day—Temperature 108·2°F. 3rd day—unsteady gait and diarrhoea. 4th day—twist of neck and diarrhoea. 5th day—highly developed nervous irritation leading to prostration	Died
Fourth	4 A	6	2nd day—Temperature 108·4°F. 3rd day—general malaise. 5th day—diarrhoea, unsteady gait and nasal discharge. 6th day—paralysis set in and death	Died
	4 B	5	2nd day—Temperature, 108·2°F. 3rd day—temperature continued same. 4th day—diarrhoea, discharges from the eyes and nostrils, general malaise	Died
Fifth	5 A	13	4th day—general malaise, slight diarrhoea; 8th day—unsteady gait and diarrhoea; 12th day—complete paralysis	Died
	5 B	3	3rd day—Temperature, 106·3°F.—head drooping. Temperature high, diarrhoea; died next day	Died
Sixth	6 A	13	4th day—general malaise, no appreciable rise of temperature. 7th day—unsteady gait. 10th day—mucus and diarrhoea; marked nervous irritation. 11th day—paralysis set in and progressed till death	Died
	6 B	11	4th day—general malaise and slight temperature. 6th day—unsteady gait; circling movement. 9th day—nervous irritation more marked	Died

Passage No.	*Duckling No.*	*Course of disease in days*	*Symptoms observed*	*Termination*
Seventh	7 A	14	4th day—general malaise which continued till the 12th day. Paralysis set in 2 days before death	Died
	7 A[1]	8	4th day—general malaise. 8th day—temperature rose to 106·8°F. and the bird was killed	Killed
	7 B	26	4th day—Temperature 108°F. and general malaise. 8th day—unsteady gait and general malaise. Progressive emaciation; no paralysis and sub-normal temperature three days before death	Died

TABLE 2.—The behaviour of Newcastle virus in serial intracerebral duckling passages

Passage No.	*Duckling No.*	*Course of disease in days*	*Symptoms observed*	*Termination*	*Infectivity to fowl*
First	1 A	3	2nd day—Temperature, 106·6°F. 3rd day—typical paralysis symptoms and diarrhoea	Died	Infective, causing death
	1 B	4	2nd day—Temperature, 106·4°F., general malaise. 3rd day—paralysis and profuse diarrhoea (no passage of this, made)	Died	Not tested
Second	2 A	5	2nd day—general malaise, no rise in temperature. 3rd day—unsteady gait; temperature rise, 106·4°F. 4th day—malaise and nervous irritability marked; 5th day—diarrhoea and full paralysis	Died	Infective, causing death
Third	3 A	4	2nd day—Temperature, 106.6°F. 3rd day—unsteady gait; drooping head; 4th day—diarrhoea, discharges from nostrils	Died	Infective, causing death
Fourth	4 A	6	2nd day—General malaise. 3rd day—unsteady gait. 5th day—high temperature, 108°F. diarrhoea, pronounced nervous irritation	Died	Infective, causing death
Fifth	5 A	4	2nd day—no temperature rise, general malaise. 3rd day—rise of temperature, 106·8°F. killed by rat before other symptoms developed. Brain passaged	Killed by rat	Infective, causing death
	5 A[1]	3	2nd day—general malaise and shivering. 3rd day—quick death due to "crop bound"	Died	Infective, causing death

Passage No.	*Duckling No.*	*Course of disease in days*	*Symptoms observed*	*Termination*	*Infectivity to fowl*
Sixth ..	6 A ..	5 ..	No appreciable temperature; 4th day—diarrhoea, no nervous symptoms noted	Died ..	Not infective
	6 A[1] ..	4 ..	No appreciable temperature reaction. 3rd day—severe diarrhoea. Killed by rat. Brain passaged	Killed by rat	Not tested
Seventh	7 A ..	4 ..	2nd day—Temperature, 108·2°F. 4th day—general malaise; nervous symptoms not noted	Died ..	No tested
	7 A[1] ..	6 .	4th day—rise of temperature, 108·2°F. 5th day—severe diarrhoea, paralysis set in	Killed ..	Not infective
Eighth ..	8 A ..	10 ..	4th day—general malaise noted. 7th day—severe nervous irritability. 8th day—diarrhoea and paralysis set in. 9th day—prostrate	Died ..	Not infective
	8 A[1] ..	4 ..	No appreciable temperature reaction. 4th day—paralysis, severe diarrhoea	Killed ..	Not infective
Ninth ..	9 A ..	6 ..	4th day—rise of Temperature to 106·2°F. 5th day—general malaise	Killed by rat	Not infective
	9 A[1] ..	6 ..	5th day—general malaise; no temperature reaction; no nervous irritation	Died ..	Not infective
Tenth ..	10 A[1] ..	2 ..	No disease symptoms seen; killed by rat; no further passage made	Killed by rat	Not tested

TABLE 8.—Response of fowls injected with brain emulsion of each duckling. Passage and the results of immunity test in surviving birds

Duckling passage	*Number of the fowl tested*	*Reaction of brain emulsion injection*	*Result of immunity test*	*Remarks*
1 ..	B 1 ..	Reacted and died ..	— ..	—
2 ..	B 2 ..	Reacted and died ..	— ..	—
3 ..	B 3 ..	Reacted and died ..	— ..	—
4 ..	B 4 ..	Reacted and died ..	— ..	—
5 ..	B 5 (1) ..	Reacted and died ..	— ..	—
	B 5 (2) ..	Reacted and died ..	— ..	—
6 ..	B 6 ..	No reaction ..	Not tested ..	Died due to heavy internal parasitism
	B 6 repeated passage	No reaction ..	Immune ..	Still living

Duckling passage	*Number of the fowl tested*	*Reaction of brain emulsion injection*	*Result of immunity test*	*Remarks*
7 ..	B 7 ..	No reaction ..	Not tested ..	Died due to heavy internal parasitism
8 ..	B 8 (1) ..	No reaction ..	Immune ..	Died subsequently due to parasitism
	B 8 ..	No reaction ..	Immune ..	do
9 ..	B 9 (2) ..	No reaction ..	Not tested ..	Died due to internal parasitism and other complaints
	B 9 (1) ..	No reaction ..	Not immune	Came down when 10,000 m.l.ds test dose was given

TABLE 4.—Showing the results of the injection of solid internal organs of test ducklings on susceptible fowls and immunity tests in surviving birds

Organs tested	*Result of injection to fowls*	*Result of immunity test*	*Remarks*
	Passage No. 4		
Liver ..	Reacted and died ..	— ..	—
Spleen.. ..	Reacted and died ..	— ..	—
Lungs ..	No reaction ..	Not immune	—
Kidneys ..	Not observed ..	— ..	Killed by rat within three days of injection
	Passage No. 5		
Liver ..	No reaction ..	Not immune	—
Spleen, kidney, and lungs mixed together ..	No reaction ..	Not immune	—
	Passage No. 6		
	(Test duckling allowed to die)		
Liver ..	No reaction ..	Not tested ..	Died due to worms before immunity test
Spleen, kidney, and lungs mixed together ..	No reaction ..	Not immune	—
	Passage No 6		
	(Test duckling killed at the height of disease)		
Liver ..	No reaction ..	Not tested ..	Died due to worms before immunity test
Spleen, kidney, and lungs mixed together ..	No reaction ..	Not immune	—

TABLE 5.—Titration of duckling brain-passed Newcastle virus from Experiment 1 in fowl egg embryos

Age of embryo in days	*No. of days after inoculation*	*Dilution used*					
		10^2	10^3	10^6	$5\ (10)^6$	10^7	10^8
		1st Passage (duckling 1B)					
10	1	S	S	S	S	S	S
11	2	S	S	S	S	S	S
12	3	D	S	S	S	S	S
13	4	—	S	S	S	S	S
14	5	—	S	S	S	S	S
15	6	—	S	S	S	S	S
16	7	—	S	S	S	D	D
17	8	—	S	S	S	—	—
18	9	—	S	S	S	—	—
19	10	—	D	D	D	—	—
		6th Passage (duckling 6B)					
10	1	S	S	S	S	S	S
11	2	S	S	S	S	S	S
12	3	S	S	S	S	S	S
13	4	D	D	D/s	S	D	D/s
14	5	—	—	D	D	—	s
15	6	—	—	—	—	—	D

Note :—(*a*) Two eggs were inoculated for each dilution.
(*b*) 0.2 cc. 10%brain emulsion is inoculum.
(*c*) 9-day incubated eggs used.
S—Surviving both embryos.
D—Dead, both or one.
D/s—One dead, living one.
s—One surviving.

TABLE 6.—Titration of duckling brain-passed Newcastle virus from Experiment IV in fowl egg embryos

Age of embryos in days	*No. of days after inoculation*	*Dilution used*					
		10^2	10^3	10^6	$5\ (10)^6$	10^7	10^8
		1st Passage (duckling 1B)					
10	1	S	S	S	S	S	S
11	2	S	D/s	S	S	S	S
12	3	D/s	D	S	S	S	S
13	4	s	—	S	S	S	S
14	5	s	—	S	S	S	S
15	6	s	—	S	S	S	S
16	7	s	—	S	S	S	S
17	8	s	—	S	S	S	S
18	9	s	—	S	S	S	S
19	10	s	—	S	S	S	S
20	11	s	—	S	S	S	S
21	12	H	—	H	H	H	H

Age of embryos in days	*No. of days after inoculation*	*Dilution used*					
		10^2	10^3	10^6	$5\ (10)^6$	10^7	10^8
		5th Passage (duckling 5A)					
10	1	S	D/s	D/s	S	D/s	S
11	2	S	s	s	S	s	S
12	3	S	s	D	D/s	D	S
13	4	S	s	—	s	—	S
14	5	D/s	D	—	s	—	S
15	6	s	—	—	D	—	D/s
16	7	s	—	—	—	—	s
17	8	D	—	—	—	—	s
18	9	—	—	—	—	—	s
19	10	—	—	—	—	—	s
20	11	—	—	—	—	—	D
		6th Passage (duckling 6A allowed to die)					
10	1	S	S	S	S	S	S
11	2	D/s	D	S	S	S	S
12	3	s	—	D/s	D	D/s	S
13	4	s	—	s	—	s	S
14	5	s	—	s	—	D	S
15	6	s	—	s	—	—	D
16	7	s	—	s	—	—	—
17	8	s	—	s	—	—	—
18	9	D	—	D	—	—	—
		6th Passage (duckling 6B killed at the height of disease)					
10	1	S	S	S	S	S	S
11	2	S	S	S	S	S	S
12	3	D	D/s	D/s	D	D/s	S
13	4	—	s	s	—	s	D
14	5	—	D	D	—	s	—
15	6	—	—	—	—	s	—
16	7	—	—	—	—	s	—
17	8	—	—	—	—	D	—

Note :—(*a*) Two eggs were inoculated for each dilution.
(*b*) 0·2 cc. 10% brain emulsion is the inoculum.
(*c*) 9-day incubated eggs used.
S—Surviving, both embryos.
D—Dead, both or one.
D/s—One dead, living one.
s—Surviving.

THE CORRECT BOTANICAL NAMES OF CERTAIN ECONOMIC PLANTS CULTIVATED IN CEYLON

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SUMMARY

THE correct botanical names and the essential synonymy with regard to Ceylon, of the following economic plants cultivated here are given: alligator pear, asparagus bean, avocado pear, bottle gourd, breadfruit, Kapok, cassava, clove, cotton, country potato, cowpea, diya labu, gingelly, innala, jak, knol-kohl, kohl-rabi, lemon, manioc, mate, Paraguay tea, pineapple, sapodilla, taro, tea, yard-long bean, and yerba mate.

The correct botanical name of a plant is that in conformity with the *International Rules of Botanical Nomenclature*. Changes in botanical names are necessitated by deeper knowledge concerning the origin of the plants, their affinities, or their cytological structure and also by the discovery of earlier valid names or on account of previous misidentification of the plants. Here are indicated the correct botanical names of certain economic plants which are often incorrectly designated.

The correct name is given first, in bold type, followed in ordinary type by the incorrect names commonly used.

1. **Achras zapota** *L.* Sp. Pl. 1190 (1753).
Achras sapota L. Sp. Pl. ed. 2. 470 (1762).
SAPODILLA.

Alligator pear = (18) *Persea americana* Mill.

2. **Ananas comosus** (*L.*) *Merr.* Interpr. Rumph. Amboin. 133 (1917).
Bromelia ananas L. Sp. Pl. 285 (1753).
Bromelia comosa L. Herb. Amboin. 21 (1754).
Ananas sativus Schult. f. ex R. et S. Syst. 1283 (1830).
PINEAPPLE.

3. **Artocarpus altilis** (*Park.*) *Fosb.* in Journ. Wash. Acad. Sc. XXXI. 95 (1941).
Sitodium altile Park. in Journ. Voy. Endeavour 45 (1773).
Artocarpus communis Forst. Char. Gen. Pl. 101 (1776).
Radermachia incisa Thunb. in Handl. K. Svensk. Vet. Akad. Stockholm XXXVII. 253 (1776).
Artocarpus incisus (Thunb.) L. f. Suppl. 411 (1781).
BREADFRUIT.

4. **Artocarpus heterophyllus** *Lamk.* Encycl. III. 209 (1789).
Artocarpus integrifolius Auct., non L. f. (1781).
Artocarpus integra sensu Merr. Interpr. Rumph. Amboin. 190 (1917), quoad nomen, non quoad plantam, ex A. F. Hill.

JAK.

Asparagus bean = (21) *Vigna sinensis* (L.) Endl. ex Hassk.
Avocado pear = (18) *Persea americana* Mill.
Bottle gourd = (16) *Lagenaria siceraria* (Mol.) Standley.

5. **Brassica oleracea** *L.* var. **gongylodes** *L.* Sp. Pl. 667 (1753).
Brassica oleracea L. var. *caulorapa* DC. Syst. Nat. II. 586 (1821).

KNOL-KOHL, KOHL-RABI.

Breadfruit = (3) *Artocarpus altilis* (Park.) Fosb.

6. **Camellia sinensis** (*L.*) *O. Ktze.* in Act. Hort. Petrop. X. 195 (1887).
Thea sinensis L. Sp. Pl. 515 (1753).
Camellia thea Link Enum. Hort. Berol. II. 73 (1822).

TEA.

Capok = (7) *Ceiba pentandra* (L.) Gaertn.
Cassava = (17) *Manihot esculenta* Crantz.

7. **Ceiba pentandra** (*L.*) *Gaertn.* Fruct. II. 244 (1791).
Bombax pentandrum L. Sp. Pl. 511 (1753).
Eriodendron pentandrum (L.) Kurz in Journ As. Soc. Bengal XLIII. 113 (1874).
Eriodendron anfractuosum DC. Prodr. I. 479 (1824).
Ceiba anfractuosa (DC.) Maza Fl. Cuba 66 (1914).

CAPOK.

8. **Citrus limon** (*L.*) *Burm. f.* Fl. Ind. 173 (1768).
Citrus medica L. β. *limon* L. Sp. Pl. 782 (1753).
Limon vulgaris Mill. Gard. Dict. ed. 8. no. 1 (1768).
Citrus limonum Risso in Ann. Mus. Paris XX. 201 (1813).
Citrus limonia Auct., non Osb. (1765).

LEMON.

Clove = (20) *Syzygium aromaticum* (L.) Merr.

9. **Coleus rotundifolius** (*Poir.*) *A. Chev. et Perr.* in A. Chev. Veg. Utiles Afr. Trop. Franc. I. 119 (1905).
Germanea rotundifolia Poir. in Lamk. Encycl. Suppl. II. 763 (1811).
Plectranthus rotundifolius (Poir.) Benth. in DC. Prodr. XII. 72 (1848).
Plectranthus tuberosus Bl. Bidjr. 838 (1826).
Coleus tuberosus (Bl.) Benth. Lab. 59 (1832), non A. Rich. (1851).
Coleus parviflorus Benth. in DC. Prodr. XII. 72 (1848).

INNALA, COUNTRY POTATO.

10. **Colocasia esculenta** (*L.*) *Schott* in Schott et Endl. Meletem. Bot. I. 18 (1832).

Arum esculentum L. Sp. Pl. 965 (1753).
Colocasia antiquorum Schott var. *esculenta* Schott Syn. Aroid. 42 (1856).
TARO.

Cotton, Asiatic = (11) *Gossypium arboreum* L.
Cotton, Egyptian = (12) *Gossypium barbadense* L.
Cotton, Kidney = (13) *Gossypium barbadense* L. var. *brasiliense* (Macf.) J.B. Hutch.
Cotton, Peruvian = (12) *Gossypium barbadense* L.
Cotton, Sea Island = (12) *Gossypium barbadense* L.
Cotton, Upland = (14) *Gossypium hirsutum* Mill.
Country potato = (9) *Coleus rotundifolius* (Poir.) A. Chev. et Perr.
Cowpea = (21) *Vigna sinensis* (L.) Endl. ex Hassk.
Diya labu = (16) *Lagenaria siceraria* (Mol.) Standley.
Gingelly = (19) *Sesamum indicum* L.

11. **Gossypium arboreum** *L.* Sp. Pl. 693 (1753) ; J. B. Hutch. Ev. Gossyp. 32 (1947).

Gossypium indicum Lamk. Encycl. II. 134 (1786).
Gossypium obtusifolium Roxb. Fl. Ind. III. 183 (1832).
Gossypium rubicundum Roxb. ex W. et A. Prodr. 55 (1834).
Gossypium nanking Meyen Reise II. 323 (1836).

Note.—Hutchinson, *l.c.* 30, states " . . . . It is proposed, therefore, to make no formal taxonomic subdivision of *G. arboreum*, but to accept Silow's [Journ. Genet. XLVI. 62 (1944)] six geographical races as representing the best natural subdivision of the species ". The Ceylon plants belong to the race *indicum*.

ASIATIC COTTON, now rarely cultivated in Ceylon.

12. **Gossypium barbadense** *L.* Sp. Pl. 693 (1753); J. B. Hutch. Ev. Gossyp. 48 (1947).

Gossypium vitifolium Lamk. Encycl. II. 135 (1786).
Gossypium peruvianum Cav. Diss. 315. t. 168 (1788).
SEA ISLAND COTTON, EGYPTIAN COTTON, PERUVIAN COTTON.

13. **Gossypium barbadense** *L.* var. **brasiliense** (*Macf.*) *J. B. Hutch.* Ev. Gossyp. 50 (1947).

Gossypium brasiliense Macf. Fl. Jam. I. 72 (1837).
Gossypium lapideum Tuss. Fl. Antilles II. 67 (1818).
Gossypium pedatum Watt in Kew Bull. 1927. 349 (1927).
KIDNEY COTTON.

14. **Gossypium hirsutum** *Mill.* Gard. Dict. ed. 7 (1759); L. Sp. Pl. ed. 2. 975 (1763) ; J. B. Hutch. Ev. Gossyp. 40 (1947).

Gossypium paniculatum Blanco Fl. Filip. 539 (1837).
Gossypium mexicanum Tod. Rel. Cult. Cot. 193 (1877).
UPLAND COTTON, commonly cultivated in Ceylon.

15. **Ilex paraguariensis** *A. St. Hil.* in Mem. Mus. Hist. Nat. Paris IX. 351 (1822).

Ilex paraguensis D. Don in Lamb. Pin. ed. 2. App. 7. t. 4 (1824).
Ilex paraguayensis Hook. in Bot. Mag. t. 3992 (1843).

PARAGUAY TEA, YERBA MATE, MATE.

Innala = (9) *Coleus rotundifolius* (Poir.) A. Chev. et Perr.
Jak = (4) *Artocarpus heterophyllus* Lamk.
Knol-kohl = (5) *Brassica oleracea* L. var. *gongylodes* L.
Kohl-rabi = (5) *Brassica oleracea* L. var. *gongylodes* L.

16. **Lagenaria siceraria** (*Mol.*) *Standley* in Field Mus. Bot. ser. 3. Fl. Yucatan 435 (1930).

Cucurbita siceraria Mol. Sagg. Chili 133 (1782).
Lagenaria vulgaris Ser. in Mem. Soc. Geneve III. 25 (1825).
Cucurbita leucantha Duch. in Lamk. Encycl. II. 150 (1786).
Lagenaria leucantha (Duch.) Rusby in Mem. Torr. Bot. Club VI.43 (1896)

BOTTLE GOURD, DIYA LABU.

Lemon = (8) *Citrus limon* (L.) Burm. f.

17. **Manihot esculenta** *Crantz* Inst. I. 167 (1766).

Jatropha manihot L. Sp. Pl. 1007 (1753).
Manihot utilissima Pohl Pl. Bras. Ic. I. 32. t. 24 (1827).

CASSAVA, MANIOC.

Manioc = (17) *Manihot esculenta* Crantz.
Mate = (15) *Ilex paraguariensis* A. St. Hil.
Paraguay tea = (15) *Ilex paraguariensis* A. St. Hil.

18. **Persea americana** *Mill.* Gard. Dict. ed. 8 (1768).
Laurus persea L. Sp. Pl. 370 (1753).
Persea gratissima Gaertn. f. Fruct. III. 222 (1805).

ALLIGATOR PEAR, AVOCADO PEAR.

Pineapple = (2) *Ananas comosus* (L) Merr.
Sapodilla = (1) *Achras zapota* L.

19. **Sesamum indicum** *L.* Sp. Pl. 634 (1753); DC. Pl. Rar. Jard. Geneve 18. t. 5. (1829).

Sesamum orientalé L. Sp. Pl. 634 (1753).

Note.—Both Linne's specific names were published at the same time. *Sesamum orientale* has page priority which, however, is not recognized under the *Rules*, and that name selected from among them by the author who first combined the two Linnean species is the correct one. De Candolle was the first to do so and he chose the name *Sesamum indicum*.

GINGELLY.

20. **Syzygium aromaticum** (*L.*) *Merr. et Perry* in Mem. Am. Acad. Arts and Sc. XVIII. 196 (1939).

Caryophyllus aromaticus L. Sp. Pl. 515 (1753).
Eugenia aromatica (L.) Baill. Hist. Pl. VI. 311 (1877), non Berg. (1854).
Eugenia caryophyllata Thunb. Diss. Caryoph. Arom. 1 (1788).

CLOVE.

Taro = (10) *Colocasia esculenta* (L.) Schott.

Tea = (6) *Camellia sinensis* (L.) O. Ktze.

21. **Vigna sinensis** (*L.*) *Endl. ex Hassk.* Pl. Jav. Rar. 386 (1848).

Dolichos sinensis L. Cent. Pl. II. 28 (1756).
Vigna unguiculata Walp. Rep. I. 779 (1842), non *Dolichos unguiculatus* L. (1753); C. V. Piper in U. S. Dep. Agr. Bur. Pl. Ind. Bull. no. 229. 143 (1912).
Dolichos catjang Burm. f. Fl. Ind. 161 (1768); L. Mant. II. 269 (1771).
Vigna catjang (Burm. f.) Walp. in Linnaea XIII. 533 (1839).
Phaseolus cylindricus L. Amoen. Acad. IV. 132 (1759).
Vigna cylindrica (L.) Skeels in U. S. Dep. Agr. Bur. Pl. Ind. Bull. no. 282. 32 (1913).
Dolichos sesquipedalis L. Sp. Pl. ed. 2. 1019 (1763).
Vigna sesquipedalis (L.) Fruw. Anbau Huelsenfr. 254 (1898).

COWPEA, ASPARAGUS BEAN, YARD-LONG BEAN.

Yard-long bean = (21) *Vigna sinensis* (L.) Endl. ex Hassk.
Yerba mate = (15) *Ilex paraguariensis* A. St. Hil.

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MANURING OF RICE

MAINTENANCE OF SOIL FERTILITY AND INCREASED PRODUCTION*

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A [illegible] in the 'Indian Farmer' [illegible] recently published by the Government of India, [illegible] in order to [illegible] a satisfactory level, should be the national aim of Food and Agricultural Policy of the Government to solve the acute food [illegible] in the country. As envisaged by Dr. Burns, Economic Agricultural Commissioner with the Government of India, a 10 per cent increase in production of cereals is urgent and there is no doubt why this could not be achieved as a result of the 'Grow More Food' Campaign launched by the Provincial and Central Governments on an intensive and extensive scale. During 1944, we produced in the Province an average of only 3 million tons of rice from 10 million acres under paddy—both irrigated and dry, and this is undoubtedly the most depressing fact about our agriculture. The low production is mainly due to lack of water and manure. It is the unanimous opinion of the Agricultural experts that given ample water and manure, the rice plant can be raised to very much higher. The average yield of wet paddy lands 2 million acres in the Province is about 1,200 lbs. per acre. The population of Madras Province is approximately 50 millions and working at the rate of 14 oz. per head, the total quantity of rice required to feed the whole population is about 5 million tons of cleaned rice per annum. In other words, we have to increase our production of the present 3 million to 5 million tons.

The improved varieties of rice could give a 10 per cent. increase. This method is engrossing our best energy but is very limited and cannot by itself solve even the fringe of our problem. The higher yields of improved strains will also require more of plant foods from our soils. The only alternative, therefore, for increasing substantially our food supply, is manuring.

The problem of increased crop production through manuring has naturally to be approached from two distinct standpoints governing the general manurial policy, namely, (1) the maintenance of soil fertility and

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* From The Farmer, Journal for Tamil Nadu, January 1946

1 Now read as the Fellow for Soil Conservation, IARI

[illegible] is increasing the soil fertility for higher production. The loss of nutrients can be restored by addition of adequate amounts of bulky organic matter such as green manure crops, oil cake, or compost from vegetable farm wastes, sugarcane, farm yard manure, etc. The increased production of dry matter per acre obtained with fertilizers on the other hand, can be maintained only by a judicious use of such available nitrogenous and phosphatic fertilizers which in combination exhibit their best.

MAINTENANCE OF FERTILITY

It is well known that crops of economic yields of certain kind [illegible] N. adapted crops. With soils of low as well as of high fertility levels, yield response per unit of fertilizer applied is more at the economic than in the optimum of limiting conditions of other factors of growth. Maximum fertility level may reasonably be defined as that yield of which the farmer is assured and wherein the addition of any unit of any plant nutrient is reflected best in terms of profit. Under the existing agronomic conditions of cultivation and measuring the maximum yield of paddy has rarely exceeded 2,000 lb. per acre. The optimum fertility level for most of our soils can therefore be stated at 2,000 lb., i.e. at 50 per cent of maximum yield. This figure can be taken as the basic fertility level of paddy soils in the Province.

The organic substances available for maintaining the basic fertility level are — (1) Green Manure, (2) Farm Yard Manure and (3) Composts.

Farm Yard Manure and Composts are required for dry and garden lands. It would not be right to divert these essential requirements of organic matter for maintaining the natural supply to paddy lands at the expense of dry lands. For lands also paddy sugarcane land crops and the present availability of Farm Yard Manure and Composts is woefully inadequate to meet even requirements.

So, that, we have to depend mainly, perhaps entirely upon green manures for maintaining the basic fertility level. It is, therefore, necessary that every acre of paddy land should grow green manure crops which may then be supposed to supply 2,000 lb. of green leaf per acre. This is a large order but not impossible.

It has been found by actual experiments conducted for a number of years in the several Agricultural Research Stations at Aduthurai, Coimbatore, Maruteru, Nellore, Pattambi and Periyakulam that fertility of paddy soils in the Province can be kept at suitable levels to produce an average yield of 2,000 lbs. by incorporating at least 5 tons of green leaf to supply about 50 lbs. N per acre. On this basis, the entire needs of our paddy soils for maintaining their fertility can be met by the cultivation of green manure crops. It is, however, desirable to supplement as far as possible supplying the entire need of green manures and emphasise the need for growing additional requirements in the form of available organics such as oil cakes.

The total quantity of groundnut cake produced is half a million tons. Fifty per cent of this is exported for cattle feed and hence 2 million tons alone will be available for manurial purposes. Practically the whole of it is being used now for such purposes very little is available for paddy. It may be desirable to ensure the supply of this and other cakes to provide at least 15 lbs. N per acre when addition of 2,000 lbs. of green manure supplying another 35 lbs. of N only will be necessary.

INCREASED PRODUCTION

We have so far considered the basic fertility maintenance of our soil in terms of yield, namely 2,000 lbs. of paddy per acre. Passing now to increased production, the plan may be fixed at any suitable target. To make our province self-sufficient in regard to rice required to feed a population of 50 million at the rate of 16 oz. of rice per day per head, we have to aim at a production of 12 million tons of paddy. As this is to be obtained mainly from 8 million acres of wet lands under this crop, our target yield should be at least 3,000 lbs. or 50 per cent. increase over production at the basic fertility level of 2,000 lbs. per acre. This has to be achieved by application of artificials only, since all our natural sources of manure are earmarked for maintenance of basic fertility and for the needs of dry lands. From an examination of the yield data relating to the manurial experiments on paddy with combination of nitrogenous and phosphatic manures providing 30 lbs. N. and 30 lbs. P_2O_5 on the typical Rice Research Stations of the Province. It is seen that 3,000 lbs. of paddy yield has been reached in only a few cases. It should not on this score be considered impossible to reach the target, high as it is, by adequate and timely application of the required fertilisers in their proper forms provided other conditions are not limiting. Since at the present time we are not in possession of the knowledge about the nature and amount of the fertilisers needed for arriving at the target of 3,000 lbs. per acre, we have to be satisfied for the time being with the programme for a lower target of about 2,500 lbs. that have actually been reached in the experiments conducted in the various research stations at Samalkota, Maruteru, Aduturai and Paramet.

TABLE 1

Results of manurial experiments on paddy

Agricultural Research Stations	*Artificials required per acre*		*Yield obtained by Manuring* lbs. per acre
	N. per acre in lb.	*P.* per acre in lb.	
Samalkota	30	30	2,700
Maruteru	44	22	2,300
Aduturai	30	30	2,700
Paramet	44	30	2,300

From the data furnished in the table, it may be seen that in most of these stations the supply of 30 lbs. P_2O_5 and 30 lbs. N. in easily available forms, such as super and ammonium sulphate, has given an average yield of about 2,500 lbs. per acre on these farms. To arrive at this target of production therefore 6 lakhs tons each of ammonium sulphate and super are required.

Further, the addition of phosphatic acid is also required for increased production of our paddy soils which are very deficient in phosphates. The application of phosphates in presence of sufficient quantity of organics, has invariably proved beneficial in increasing appreciably the yield of paddy crop. It is therefore absolutely essential for the maintenance and increase of soil fertility that our lands should receive a minimum basic dose of phosphates to supply at least 30 lbs. P_2O_5. Our available phosphatic resources, apart from Trichy rock phosphate, are bones and fish guano only. Exact figures for the last two are not available. It is felt, however, that the

quantity of phosphates from both the sources will be far short of our basic requirements. The deficit in regard to this important fertilizer has to be made good by mineral manures to be manufactured in this country and obtained from abroad.

Thus, the total phosphoric acid requirement for increased crop production will, as mentioned before be 6 lakhs tons of super. This may have to be met by starting local industries for phosphoric acid production and or by imports. Similarly 6 lakhs tons of ammonium sulphate, required for the supply of N. have to be manufactured or obtained from outside.

Based on the above considerations the following schedule of manuring for the paddy tracts of the presidency is recommended to give an average yield of about 2,500 lbs. paddy per acre.

1. Basic—Green manure to supply 30 lbs. N. .. .. 5,000 lbs

or

Green manure to supply 15 lbs. N. .. .. 2,500 lbs.

Plus

Oil cake to supply 15 lbs. N.

Plus

2. Ammonium sulphate or any nitrogenous fertilizer to supply 30 lbs. N.

Plus

3. Super or any phosphatic fertilizer to supply 30 lbs. P_2O_5.

The significance of adequate and proper manuring has been well understood by the advanced countries like Japan, Spain and Italy. In Japan, composting of waste materials for application to rice, growing of green manure and liberal use of the human excreta, have been practised from a very long time.

Artificial fertilizers, such as, super and ammonium sulphate, are supplied with the organics and the dosage is, as much as 70 to 80 lbs. of N. in the shape of sulphate of ammonia and about 50 to 60 lbs. P_2O_5 as super. The sale of the chemical fertilizers is made through Co-operative Societies. Superior varieties of paddy evolved by breeding, occupy more than 70 per cent. of the rice area in this country and the number of strains introduced are also limited. The distribution of manure is efficiently controlled by the State. Turning to Spain and Italy in the west, it is no wonder to note that with the magnificient system of irrigation prevailing in these countries, coupled with heavy applications of artificials, viz., ammonium sulphate, super and potash the average yield has gone up to the enviable figure of 5,000 lbs. per acre. The practice current in these advanced countries may be emulated to the maximum possible extent, to raise the yield of paddy in our Province.

Above all, the productive capacity of each type of soil should be assessed in relation to its environment and make up. This factor is not directly proportional to the amount of fertilizer applied. A cultivated field should be judged as a biological entity or organism and is therefore subject to the laws governing the organic. It has its critical point of inner effective power which is the resultant of a number of factors. In the words of Pfeiffer [Soil Fertility, Renewal and Preservation, Faber and Faber, Limited, Lond. (1945)—pp. 148–163] " the natural fertility and production capacity are the functions of (1) the soil; (2) manuring; (3) humus; (4) rotation;

5) climate ; (6) weather conditions ; (7) quality of seed ; (8) weed growth and a host of environmental factors ". All these should be borne in mind in the management of our paddy lands for maximum crop production.

Another equally important point to be considered is the economic use of fertilizers avoiding wastage and resorting to right method of their application at the proper time. Recent. work indicates that small application of fertilizers in close proximity to the seed, the pre-soaking of the seed material in nutrient solutions of phosphates, &c. may be effective in increasing the crop yield. Splitting of the doses of manures and their application at different stages of plant growth, has also been found, efficient in improving the yield and quality of crops.

In fine, maximum cropping which is closely allied to maintenance of soil fertility demands ingenuity on the part of the farmer, combined with a thorough understanding of his soil and its capabilities. Apart from judicious manuring, careful planning, skilful cultivation and wise selection of variety are also equally important for solving our cropping problems and food shortage.

GOOD CROPS FROM POOR LAND

TREATMENT OF SEED INSTEAD OF SOIL

BY

DR. W. A. ROACH,*

EAST MALLING RESEARCH STATION, ENGLAND

LARGE increases in yield, as a result of soaking cereal seed in suitable nutrient solution before sowing in nutrient deficient soil, were obtained on the experimental scale by Mrs. W. O. Roberts, a member of a team set up by Britain's Agricultural Research Council to work on the diagnosis and cure of mineral deficiencies in plants.

The work had two objects. First, to find out whether it was possible to introduce into the seed enough of the major nutrients, phosphorous and potassium, in a readily available form to carry the young plant through its early stage before its root system was sufficiently developed to make full use of available supplies of these nutrients in the soil, and secondly to discover whether the same would apply to trace element on soils known to produce trace element deficiencies.

The most important result was obtained by soaking oats in about one third of their weight of 21 per cent. tribasic potassium phosphate ($K_3 PO_4$) solution, and sowing in soil known to be deficient in phosphate. The yield from untreated seed was 17, from water-soaked 20, and from phosphate soaked, seed 25 bushels to the acre ; and there were correspondingly large increases in straw. This was equivalent to using 3·4 pounds $P_2 O_5$ per acre, of which no less than 73 per cent. was recovered in the harvested grain, suggesting a high degree of efficiency of utilization of phosphate. In another experiment on oats, phosphate was found to be more than seven times as efficient when soaked as when sown with the seed, and in an experiment on wheat it was 60 times as efficient. Large increases in yield were also obtained in barley.

A WARNING

It must be emphasized that these hopeful results were on an experimental scale and that the process has not yet been applied on the large scale. There are certain conditions that have been found to be essential for success, and a warning must be given that unless these conditions are satisfied the grain may easily be damaged or killed.

* From *The Planters' Journal*—Vol. XLI, No. 1, January, 1949.

The volume of solution must be so chosen that all of it is absorbed within 24 hours. When grains are soaked valuable substances are extracted by the water or solution and unless the solution is absorbed completely they are lost and the grain is consequently damaged. Cereal grains absorb about one-quarter of their weight of water or nutrient solution.

The soaked seed may be sown broadcast by hand without drying, but if this procedure is adopted the wet grain must be sown immediately because it soon " heats " when stored in a heap when moist.

If the seed cannot be broadcast immediately after soaking, or if it is to be sown by drill, it must be dried. The safest drying method is to expose the grain in a thin layer to a current of dry air at normal temperature with frequent turning. If artificial heat is used it is most important that the temperature must not rise above 22° Centrigrade in the early stages because grains are particularly susceptible to heat injury when moist. The grain should be dried to its original weight ; excessive drying is to be avoided.

When soaked grain is dried to its original weight it will be found that it has increased in volume by about one-third. Allowance must be made for this when adjusting seeding rates.

THREE CEREALS

The choice of the most suitable compound of the nutrient element to be used in solutions for soaking seeds is important and it was found that some compounds are to be avoided. For example, all ammonium salts which tend to be poisonous—while there appears to be a particular compound which is the best for each of the cereals. In the case of phosphates, the best form for oats is tripotassium phosphate (trisodium phosphate seemed equally good when there was no soil deficiency of potassium). For wheat, potassium dihydrogen phosphate seems best, used at a concentration of five per cent., and for barley, dipotassium hydrogen phosphate at 17 per cent. Large increases in yield were obtained by soaking the three cereals in the three solutions mentioned, but it will be noted that all three contain potassium, to which part of the increases may have been due. If phosphate alone is required, the obvious choice, as being easily obtainable, would be triple superphosphate, but unfortunately an experiment with this form of phosphate became waterlogged, and its suitability was not established.

The " soaked " nutrient is held in the outer layers of the seed, where it is readily available to the rootlets of the developing seedlings, but it is readily dissolved out again if the grain is subjected to excessively wet conditions, consequently soaked seed is likely to give better results on well drained, than on poorly drained, soils, and may be inffective on a waterlogged soil.

The greatest future for seed-soaking may well be on soils that are not only deficient of phosphate but also fix any phosphate added to them in a form that is unavailable to the plant. Phosphate soaked into the outer layers of the seed is largely protected from this soil fixation and, as already stated, is readily available to the rootlets of the developing plant. There are vast areas of such phosphate deficient soils that also fix phosphate added to them. The extremely efficient uptake of soaked phosphate into the plant

leading to large increases in yields in relation to the phosphate used, already mentioned, suggests that the method is well worth trying in the many areas of the world where phosphate has to be transported over great distances.

ANOTHER SUCCESS

In the time available only a few experiments could be carried out to see how far micro-nutrient deficiency could be prevented by seed-soaking. One experiment proved quite clearly that soaking seed in manganese sulphate before sowing in manganese-deficient soil, resulted in the seedling remaining green and healthy some weeks after those from untreated seed had died. Some soils are so deficient of manganese that seedlings die soon after the first leaf appears above the surface and before spraying can be effective. The results of the experiment just mentioned suggested that on such soils seed-soaking might well carry the seedling through this early critical stage until there was enough leaf development for manganese spraying to be effective.

Mrs. Roberts has written a more detailed account of her work for a number of Britain's *Journal of Agricultural Science*. It is to be regretted that circumstances made it impossible to continue the work beyond the experimental stage to full scale field trials, especially as it suggested the possibility of very large economies in the use of phosphates and, perhaps, also potash, together with increases in yield, and pointed to a possible new way of dealing with trace element deficiency problems.

T. PETCH

Tom Petch, B.A., B.Sc., died at his home at Wootton in England on Christmas Eve, at the age of 79. His passing will be felt as a great loss to British and Tropical Mycology.

He came to Ceylon in 1905 as Mycologist to the Royal Botanic Gardens. On the retirement of Dr. J. C. Willis in 1912, he assumed responsibility for systematic botany as well as mycology in the newly constituted Department of Agriculture. He relinquished that post in 1925 to become the first Director of the Tea Research Institute of Ceylon. He retired in 1928 to rejoin his family in England after spending twenty-three arduous years in Ceylon.

On arrival his attention was immediately directed towards the disease problems of plantation crops, cacao, coconut, tea and rubber. At that time the planting of rubber trees was booming and he devoted much time to the study of the problems of that expanding industry. In 1911 he published "The Physiology and Diseases of Hevea brasiliensis", and in 1921 a revised and more complete account of the diseases of that tree under the title "Diseases and Pests of the Rubber Tree". His tea book "The Diseases of the Tea Bush" was not published till 1923, but meanwhile numerous articles on the diseases of many economic crop plants appeared in the pages of the *Tropical Agriculturist*. As his work became known to agriculturists in the tropics and to scientific institutes, Peradeniya became a recognized centre of mycological knowledge, and requests for advice and assistance were received from many parts of the world.

Although Petch will be best remembered by the planting community for his work on the diseases of plantation crops his interests extended far beyond pathology. He was a born naturalist with interests in all living things but with a special liking for fungi. His first paper on New Ceylon Fungi appeared in 1906 and his revisions of Ceylon fungi started in 1907. Since then there has been a long succession of papers, his object being to describe accurately all known fungi of Ceylon. It was a large undertaking, but with it he established Ceylon mycology on a sound foundation. Later he became especially interested in entomogenous fungi and his work in that sphere established his reputation as a world authority.

Petch's knowledge of the Ceylon flora was very extensive. Although mycology was his main study he yet found time to devote to systematic botany. His papers on Aristolochia, Cryptogyne, Gregarious flowering, Buttress roots, &c., indicate his diversity of interests.

Mycology was originally Petch's hobby, and after it became his profession it still remained his hobby. His outturn of scientific papers was prolific, and the question was sometimes asked how he found time to do it all. He spent his short leaves in Ceylon at his cottage near Hakgala Gardens, taking with him his notes so that he might write undisturbed by official correspondence, and returning with new collections for further study. Much of his home leave was spent in Herbaria in Paris, London and elsewhere comparing his Ceylon specimens with the original types. He always seemed to be at work—or was he pursuing his hobby ? His interests never dimmed and papers for publication continued to flow from his pen till death intervened. Whatever he wrote, whether in official correspondence or for publication was precise and clear, occasionally trenchant.

He was essentially a field man and always maintained that the proper place to study fungi was in their natural habitat and not in test-tubes. Of course he recognized the value of laboratory studies but there was nothing he detested more than what he termed a "test-tube

species ". He was a keen observer and little missed his observation. It was once said of him that he wore spectacles not to enable him to see, but to ensure that he saw better than anyone else.

The Tea Research Institute was fortunate in having Petch as its first Director. Though he held the post for but a few years his able advice and thorough knowledge of the industry and its requirements were invaluable during its establishment and early years. He laid the excellent foundation on which others have built.

Petch was of a quiet, retiring disposition, hating publicity. He always preferred to work quietly and unobtrusively in the background. He was never very prominent in Committees, having little to say, but that little was always to the point and full of sound advice. Although of a naturally reserved character those who knew him best will remember his kindly manner and droll humour.

C. H. Gadd.

RUBBER RESEARCH SCHEME (CEYLON)

MINUTES OF THE EIGHTY-NINTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION BUILDING, COLOMBO, AT 2.30 P.M. ON MONDAY, OCTOBER 25, 1948.

Present.—Mr. D. Rhind (Director of Agriculture) in the Chair, Mr. H. E. Peries, C.C.S. (Acting Deputy Secretary to the Treasury), Mr. W. H. Attfield, Mr. H. St. J. Cole Bowen, Mr. C. A. C. Bowen, Mr. Noel de Silva, Mr. E. R. de Silva, Mr. W. P. H. Dias, J.P., Mr. T. C. A. de Soysa, Mr. F. H. Griffith, M.P., Mr. R. J. Hartley, Mr. Errol A. Jayewickreme, Mr. A. D. Layton, Mr. V. T. Nanayakkara, M.P., and Mr. F. A. Obeyesekere.

Dr. E. Rhodes, Director, was present by invitation.

A letter regretting inability to be present was received from Mr. V. G. W. Ratnayake, M.P.

1. MINUTES

Draft minutes of the meeting held on May 31, 1948, which had been circulated to members, were signed by the Chairman on signification of members' assent that they were in order.

2. DECISIONS BY CIRCULATION OF PAPERS

Renting out 2 Staff Bungalows at Dartonfield.—Reported that the proposal to rent out senior staff bungalows No. 1 and 3 to the Medical Officer of Health, Agalawatta, and Medical Officer of Health, Matugama, respectively had received the approval of members. The bungalows had therefore been rented out.

3. BOARD

The Chairman reported the following changes in membership :—

(*a*) Mr. H. E. Peries, C.C.S., Acting Deputy Secretary to the Treasury, had been nominated to represent the Minister of Finance in place of Mr. T. D. Perera, C.C.S., with effect from August 21, 1948.

(*b*) Major Montague Jayewickreme had been nominated as a representative of Parliament with effect from June 8, 1948, in place of Mr. George E. de Silva whose membership had terminated.

(*c*) Mr. V. T. Nanayakkara, M.P., had been nominated as a representative of Parliament with effect from June 9, 1948, in place of the late Mr. Simon Abeywickreme.

(*d*) Mr. V. G. W. Ratnayake, M.P., had been nominated as a representative of Parliament with effect from June 25, 1948, in place of Mr. Thomas Amarasuriya whose membership had terminated.

(*e*) Mr. W. H. Attfield had returned to the island and resumed his seat with effect from August 6, 1948, relieving Mr. R. Bois.

(*f*) Mr. F. H. Griffith, M.P., had been re-nominated as a representative of the Planters' Association of Ceylon for a further period of three years from November 16, 1948.

(*g*) Mr. H. St. J. Cole Bowen had been nominated as a representative of the Agency Section of the Planters' Association of Ceylon, with effect from October 22, 1948, in place of Mr. E. J. O. Richardson who had resigned.

(*h*) Mr. F. A. Obeyesekere had been re-nominated as a representative of smallholders for a further period of three years from November 26, 1948.

The new members were welcomed to the Board and the retiring members were thanked for their services.

4. **SMALLHOLDINGS COMMITTEE**

Recommendations made at meeting held on September 17, 1948 :

(*a*) *New Rubber Planting Scheme.*—Reported that the activities of the New Rubber Planting Scheme had been taken over with effect from October 1, 1948, and that a special grant for this work would be received annually from Government. 2 Assistant Propaganda Officers, 2 District Field Officers, 24 Rubber Instructors, 2 Clerks and 1 Peon had been appointed from the staff of the N. R. P. S. Their appointments were approved and the Director's proposals for administering the enlarged Smallholdings Department were also approved.

The minutes were adopted.

5. **EXPERIMENTAL COMMITTEE**

Recommendations made at meeting held on September 24, 1948 :

Research programmes for 1949—were approved.

The minutes were adopted.

6. **REPORTS AND ACCOUNTS**

(*a*) *Director's reports for 1st and 2nd quarters, 1948*—were approved.

(*b*) *Draft estimates for 1949.*—Draft estimates for 1949 providing for income and expenditure as follows were approved and it was noted that the financial position was generally better than anticipated last year :—

		Rs.
Estimated income		583,353
Estimated expenditure :	Rs.	
On Revenue Account ..	627,470	
On Capital Account ..	67,972	
		695,442
Estimated excess of expenditure over income ..		112,089

(*c*) *Statements of Receipts and Payments for the 1st and 2nd Quarters, 1948*—were approved.

(*d*) *Fixed Deposit.*—The Chairman reported that a sum of Rs. 100,000 had been placed on fixed deposit with the Bank of Ceylon, Colombo, for one year from October 8, 1948, at ¾ per cent. interest per annum. Approved.

(*e*) *Estate Accounts, January to June, 1948*—Dartonfield, Nivitigalakele and Hedigalla accounts, January to June, 1948, were tabled.

7. **STAFF**

(*a*) *Smallholdings Propaganda Officer.*—The Chairman reported that Mr. W. I. Pieris, Smallholdings Propaganda Officer, had accepted re-engagement for a further period of 4 years and 3 months from April 1, 1948, on the terms laid down for locally recruited senior technical officers.

Mr. Obeyesekere left the meeting.

(*b*) *Recruitment of Oidium Research Officer.*—A request from the Permanent Secretary to the Ministry of Agriculture and Lands that steps be taken to appoint an Oidium Research Officer was considered. Certain Members stressed the importance and value of an appointment of this nature and it was agreed after discussion that an advertisement be issued in scientific journals in Europe, America, Australia and South Africa for a Mycologist for full-time work on *Oidium heveæ*. It was agreed that the initial salary should be a point in the scale Rs. 12,000—600—25,800, according to qualifications and experience.

(*c*) *Research Assistants.*—The Chairman reported that Messrs. D. M. Fernando, B.Sc. (Ceylon) and W.M. S. Wijeratne, B.Sc. (Ceylon) had been appointed Research Assistants in the Botanical and Chemical Departments respectively on the approved salary scale and terms of service. They were expected to assume duties on November 1 and November 8, respectively. The appointments were approved.

8. **PROPOSALS BY DIRECTOR FOR FUTURE SALARIES AND SERVICE CONDITIONS OF STAFF**

A memorandum by the Director containing proposals for revising the salaries and service conditions of the staff was considered. The difficulty of obtaining suitable men as Research Officers on the present salary scale was recognized and it was agreed that the proposed scales for the Director, Senior Technical Officers and Graduate Research Assistants be adopted with effect from the date when the anticipated increase in cess becomes operative. The rest of the proposals were referred to the Experimental Committee for consideration.

Mr. Griffith left the meeting.

9. **TRAINING IN RUBBER CULTIVATION**

A letter from the Permanent Secretary to the Ministry of Agriculture and Lands enquiring whether a course of training in rubber cultivation could be provided for Indian graduates was considered. It was agreed that this would not be possible owing to the shortage of senior technical staff.

10. **LONDON ADVISORY COMMITTEE**

Minutes of Meetings of the Committee and the Technical Sub-Committee held on July 2, 1948—were tabled.

11. **PUBLICATIONS**

The Annual Report for 1947 was tabled.

The meeting then terminated with a vote of thanks to the Chair.

Dartonfield,
Agalawatta, November 16, 1948.

C. D. DE FONSEKA,
Secretary-Accountant.

RUBBER RESEARCH SCHEME (CEYLON)

MINUTES OF THE NINETIETH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, DECEMBER 20, 1948

Present.—Mr. D. Rhind (Director of Agriculture) in the chair, Mr. H. E. Peries, C.C.S. (Deputy Secretary to the Treasury), Mr. W. H. Attfield, Mr. W. P. H. Dias, J.P., Mr. Noel de Silva, Mr. E. R. de Silva, Mr. T. C. A. de Soysa, Mr. F. H. Griffith, M.P., Mr. R. J. Hartley, Mr. E. Jayewickreme, Mr. V. T. Nanayakkara, M.P., Mr. R. C. L. Notley, Mr. F. A. Obeyesekere and Mr. V. G. W. Ratnayaka, M.P.

Dr. E. Rhodes, Director, was present by invitation.

A letter regretting inability to be present was received from Mr. C. A. C. Bowen.

1. MINUTES

(*a*) *Signing.*—Draft minutes of the meeting held on October 25, 1948, which had been circulated to members, were signed by the Chairman on signification of members' assent that they were in order.

(*b*) *Matters arising from the minutes*—

Appointment of Oidium Research Officer.—The Chairman reported that an advertisement had been issued in scientific journals in London, Holland, America, Australia, South Africa ; also in Malaya and Ceylon.

2. BOARD

The Chairman reported that Mr. R. C. L. Notley had returned to the Island and resumed membership with effect from December 2, 1948, relieving Messrs. A. D. Layton and T. C. A. de Soysa who had acted for him on the Board and Experimental Committee respectively.

3. AMENDING ORDINANCE

It was reported that an amending Ordinance providing for an increased cess at the rate of 55 cents per 100 lbs. of rubber exported from Ceylon had been passed by Parliament with effect from January 1, 1949. A letter from the Permanent Secretary to the Ministry of Agriculture and Lands stating that the amending Ordinance also provided for certain changes in the constitution of the Board was read and it was noted that that was the last meeting of the Board as at present constituted. The Chairman thanked all members for the valuable advice and assistance rendered by them.

4. DIRECTOR'S RESIGNATION

The Chairman reported that Dr. E. Rhodes, Director, had given 6 months' notice of resignation, owing to domestic reasons. Members expressed regret at the loss of a valuable officer. The resignation was accepted and it was agreed that the post be advertised in Ceylon and abroad.

4—J. N. A 89501 (6/49)

5. **EXPERIMENTAL COMMITTEE**

Recommendations made at meeting held on November 29, 1948 :—

(*a*) *Bungalow at Nivitigalakele.*—Agreed that the vacant senior staff bungalow at Nivitigalakele be rented to Mr. J. H. M. Toussaint, Assistant Superintendent of Police, Matugama.

(*b*) *Proposals by Director for future salaries and service conditions of staff.*—It was noted that the Committee had recommended the adoption of the Director's proposals subject to certain amendments. The Committee's recommendations were adopted and it was agreed that the new salary scales and conditions of service should be effective from January 1, 1949.

6. **REPORTS AND ACCOUNTS**

(*a*) *Director's Report for the 3rd quarter, 1948*—was approved.

(*b*) *Auditor's Report and Balance Sheet for 1947*—were adopted.

(*c*) *Supplementary vote and revote of 1947 capital votes.*—A supplementary vote (for 1949) of Rs. 2,000 was passed to cover the cost of establishing a clonal seedling nursery at Nivitigalakele for supplying material for experimental planting at Hedigalla and for issue to smallholders.

Balances of 1947 capital votes amounting to Rs. 117,968 were re-voted.

(*d*) *Inventory Report for 1947.*—This was approved and it was agreed that the missing and unserviceable items be written off the inventories.

(*e*) *Statement of Receipts and Payments for the 3rd quarter, 1948*—was approved.

(*f*) *Estate Accounts, July to September, 1948*—were tabled.

7. **STAFF**

Changes in junior staff were reported.

As that was the last meeting of the Board Mr. Obeyesekera, the most senior member, referred to the hearty co-operation and assistance rendered to the Board by the Chairman, the Director and members of the staff. He proposed a vote of thanks to the Chairman and the Scheme's officers in sincere appreciation of their services. In seconding the vote of thanks Mr. Dias made special reference to the valuable services of Mr. Griffith as Chairman of the Experimental Committee for a number of years. The Chairman and the Director thanked the members for the sentiments expressed.

The meeting then terminated.

Dartonfield,
Agalawatta, January 18, 1949.

C. D. DE FONSEKA,
Secretary-Accountant.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED OCTOBER 31, 1948

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1948	From Jan. 1, 1948, to Oct. 31, 1948			
				Deaths	Recoveries	Balance Ill	Number Shot.
Western Province	Foot-and-mouth	—	8	—	8	—	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and-mouth	—	307	—	307	—	—
	Rabies	9	71	—	—	—	71
Colombo Cattle Quarantine Station	Anthrax	2	33	33	—	—	—
Northern Province	Black Quarter	—	9	9	—	—	—
	Rabies	—	2	—	—	—	2
	Foot-and-mouth	256	808	506	302	—	—
Sabaragamuwa Province	Foot-and-mouth	—	558	13	545	—	—
North-Western Province	Mange in goats	—	16	—	16	—	—
North-Central Province	Foot-and-mouth	—	567	10	557	—	—
Southern Province	Anthrax	—	5	5	—	—	—
	Foot-and-mouth	—	760	24	736	—	—
	Rabies	—	3	3	—	—	—
	Black Quarter	—	4	3	1	—	—
Central Province	Rabies	—	16	13	—	—	3
	Piroplasmosis	—	1	—	1	—	—
	Foot-and-mouth	—	21	—	21	—	—
	Anthrax	1	1	1	—	—	—
Uva Province	Foot-and-mouth	—	109	—	109	—	—
	Rabies	—	3	1	—	—	2
	Piroplasmosis	—	1	—	1	—	—

Peradeniya, December 1, 1948.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and
Government Veterinary Surgeon.

5—J. N. A 80501 (6/49)

ANIMAL DISEASE RETURN FOR THE MONTH ENDED NOVEMBER 30, 1948

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1948	From Jan. 1, 1948, to Nov. 30, 1948			
				Deaths	Recoveries	Balance Ill	No. Shot
Colombo Municipality	Foot-and-mouth	—	307	—	307	—	—
	Rabies	7	78	—	—	—	78
Colombo Cattle Quarantine Station	Anthrax	1	34	34	—	—	—
Western Province	Foot-and-mouth	—	8	—	8	—	—
	Rabies	—	1	1	—	—	—
Northern Province	Black Quarter	—	9	9	—	—	—
	Rabies	—	2	—	—	—	—
	Foot-and-mouth	135	943	626	317	—	—
Sabaragamuwa Province	Foot-and-mouth	—	558	13	545	—	—
North-Western Province	Mange in goats	—	16	—	16	—	—
North-Central Province	Foot-and-mouth	—	567	10	557	—	—
Southern Province	Anthrax	—	5	5	—	—	—
	Foot-and-mouth	—	760	24	736	—	—
	Rabies	—	3	3	—	—	—
	Black Quarter	—	4	3	1	—	—
Central Province	Rabies	—	16	13	—	—	3
	Piroplasmosis	—	1	—	1	—	—
	Foot-and-mouth	—	21	—	21	—	—
	Anthrax	—	1	1	—	—	—
Uva Province	Foot-and-mouth	—	109	—	109	—	—
	Rabies	—	3	1	—	—	2
	Piroplasmosis	—	1	—	1	—	—

Peradeniya, January 17, 1949.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED DECEMBER 31, 1948

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1948	From Jan. 1, 1948, to Dec. 31, 1948			
				Deaths	Recoveries	Balance III	No. Shot
Western Province	Foot-and-mouth	—	5	—	5	—	—
	Rabies	3	4	4	—	—	—
Colombo Municipality	Foot-and mouth	—	307	—	307	—	—
	Rabies	10	88	—	—	—	88
Colombo Cattle Quarantine Station	Anthrax	4	38	38	—	—	—
Northern Province	Black Quarter	—	9	9	—	—	—
	Rabies	—	2	—	—	—	2
	Foot-and-mouth	—	943	626	317	—	—
North-Western Province	Mange in goats	—	16	16	—	—	—
North-Central Province	Foot-and-mouth	381	948	12	814	122	—
Sabaragamuwa Province	Foot-and-mouth	—	558	13	545	—	—
Southern Province	Anthrax	—	5	5	—	—	—
	Foot-and-mouth	—	760	24	736	—	—
	Rabies	—	3	3	—	—	—
	Black Quarter	—	4	3	1	—	—
Central Province	Rabies	—	16	13	—	—	3
	Piroplasmosis	—	1	—	1	—	—
	Foot-and-mouth	—	23	—	23	—	—
	Anthrax	—	1	1	—	—	—
Uva Province	Foot-and-mouth	—	109	—	109	—	—
	Rabies	—	3	1	—	—	2
	Piroplasmosis	—	1	—	1	—	—

Peradeniya, February 17, 1949.

T. M. Z. MAHAMOUTH,
Deputy Director Animal Husbandry
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, OCTOBER, 1948

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		In.		In.
Agalawatta	86·7	+1·1	71·4	—1·0	81	98	7·2	22·25	23	+ 3·49
Anuradhapura	91·6	+2·7	73·9	+0·5	70	90	7·5	8·91	15	— 0·81
Badulla	83·8	+1·0	65·2	—0·3	78	97	6·8	12·25	20	+ 3·36
Batticaloa	87·0	0	76·1	+0·9	75	86	7·5	6·04	14	— 1·15
Colombo	86·4	+1·5	74·3	—0·5	80	90	6·9	8·97	22	— 4·74
Diyatalawa	76·4	+0·1	59·5	—1·1	80	94	7·7	10·87	18	+ 1·69
Galle	83·8	+0·8	74·9	—0·5	83	90	7·3	17·95	21	+ 5·90
Hakgala	70·8	+0·7	57·4	+1·4	80	81	7·6	8·15	16	— 3·13
Hambantota	86·3	+0·1	75·4	+0·2	80	88	6·6	10·77	13	+ 6·01
Jaffna	87·9	+2·2	78·1	+0·6	77	87	6·7	4·44	9	— 4·76
Kandy	86·1	+1·9	68·4	—0·1	76	92	7·4	9·49	21	— 1·05
Kurunegala	89·9	+2·5	73·3	+0·2	74	90	6·0	11·61	17	— 3·25
Lunuwila	87·1	+1·5	73·8	—0·4	80	95	6·4	20·71	18	+ 9·82
Mannar	87·9	+1·0	77·9	+0·7	75	84	7·0	1·98	10	— 4·60
Nuwara Eliya	69·1	+1·5	50·4	—1·5	83	93	7·4	8·25	19	— 1·51
Puttalam	87·4	+1·1	75·1	—0·4	78	88	7·1	9·13	12	+ 1·70
Ratnapura	88·8	+1·8	72·6	—0·2	80	98	7·7	10·23	20	— 7·78
Talawakele	75·2	+1·8	56·7	—1·1	84	94	6·0	6·97	19	— 3·09
Trincomalee	88·1	+0·4	75·4	—0·1	78	88	6·2	7·71	18	— 1·84

Rainfall in October was irregularly distributed on both sides of average. The larger deficits were found in the northern parts, on the south-western slopes of the hills and the adjacent mid-country, and in the North-Western Province. The biggest shortfalls were 14·51 inches at Hapugastenne Estate, 12·28 inches at Blackwater Estate, and 12·10 inches at Watawala. The larger excesses were found in the south-eastern parts of the Island and scattered in places elsewhere, the highest being 9·40 inches at Labuduwa, 7·55 inches at Gonapenigala Estate, and 7·47 inches at Maha Lewaya, Hambantota.

Heaviest rain occurred in a small area in the south-western low-country around Agalawatta where the totals exceeded 20 inches, Gonapenigala Estate aggregating 29·17 inches for the month, Gikiyanakande Estate 24·19 inches, Labuduwa 23·85 inches, and Sirikandura Estate 23·10 inches. Elsewhere the rainfall generally ranged from 5 to 10 inches or 10 to 15 inches. Least rain was experienced in the northern parts and in Batticaloa District where the totals for the month were of the order of two to three inches.

There were 27 daily falls of 5 inches or over in October, nearly all of them occurring on the 21st. The highest were 10·62 inches at Lunuwila, and 10·05 inches at Sirikandura Estate, all on the 21st.

Temperatures were appreciably above normal by day and generally below normal by night. The highest recorded shade temperature was 97·6°F at Trincomalee on the 1st, while the lowest air temperature was 44·6° at Nuwara Eliya on the 8th. Humidities and cloud amounts were above normal. Wind direction was variable.

D. T. E. DASSANAYAKE,
Superintendent, Observatory.

METEOROLOGICAL REPORT, NOVEMBER, 1948

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		In.		In.
Agalawatta	87·6	+1·2	70·9	—0·7	82	97	7·3	19·71	23	+ 1·19
Anuradhapura	87·9	+2·3	72·6	+1·0	74	93	6·5	12·56	17	+ 1·89
Badulla	80·5	+1·3	64·7	—0·9	82	94	6·4	6·57	20	— 3·68
Batticaloa	84·6	+0·5	74·4	+0·1	80	90	7·1	9·23	18	— 4·63
Colombo	86·4	+1·3	73·5	+0·1	82	95	6·4	12·32	18	— 0·77
Diyatalawa	73·1	—1·0	59·5	—0·6	86	97	7·8	12·85	24	+ 2·43
Galle	84·3	+0·9	74·6	+0·3	84	93	6·7	12·74	20	+ 0·73
Hakgala	66·0	—2·7	53·8	—1·1	79	100	7·6	7·57	18	— 4·76
Hambantota	85·2	0	74·4	+0·4	82	93	5·4	8·62	11	+ 1·05
Jaffna	85·9	+2·1	76·2	+1·5	80	91	6·5	12·86	19	— 4·41
Kandy	85·2	+1·3	68·4	+0·3	78	92	7·4	9·48	19	— 1·54
Kurunegala	88·2	+1·3	72·6	+0·7	78	93	6·0	11·20	18	— 1·19
Lunuwila	87·1	+1·1	73·5	+0·8	82	95	5·3	5·30	21	— 8·46
Mannar	86·3	+1·8	76.3	+0·8	81	88	6·8	15·14	18	+ 4·95
Nuwara Eliya	68·1	+0·4	49·5	—1·9	86	90	7·0	6·92	17	— 2·27
Puttalam	87·0	+1·5	73·8	+0·5	80	93	6·2	7·50	15	— 2·63
Ratnapura	88·8	+1·4	72·4	0	80	95	7·4	8·61	24	— 6·18
Talawakele	74·5	+1·0	57·1	—0·3	78	91	6·5	6·38	18	— 2·12
Trincomalee	85·8	+2·4	75·6	+0·8	80	88	5·6	7·34	17	— 6·60

Rainfall in November was below normal over a large portion of the Island, the bigger deficits (of the order of 5 to 10 inches) occurring in Jaffna Peninsula and in central and western parts of the Island. The outstanding shortfalls were 12·46 inches at Hendon Estate, 9·59 inches at Oonoogaloya Estate, and 9·48 inches at Heneratgoda. Excesses were found chiefly in the southern and south-eastern parts, the greatest being 10·38 inches at Balangoda, 8·83 inches at Beausejour Estate, and 8·53 inches at Udahena Estate.

At most stations the rainfall for the month ranged from 5 to 15 inches. The larger totals were found in the south and south-east, where several stations recorded over 20 inches, the highest being 29·24 inches at Udahena Estate, 28·79 inches at Kolonna, and 24·26 inches at Anningkande Estate. There were a few scattered stations receiving less than 5 inches for the month, e.g., 3·49 inches at Minneriya, 3·58 inches at Hankole Estate, and 3·60 inches at Alagalla.

There were 19 daily falls of five inches or over, the highest being 6·96 inches recorded both at Pindeniya on the 30th and at Sudupanawela on the 28th.

Temperatures were above normal particularly by day. The highest recorded shade temperature was 93·8° at Trincomalee on the 3rd, while the lowest air temperature was 39·6° at Nuwara Eliya on the 26th. Humidities were above average, while cloud amounts were about average. Wind direction was generally variable.

D. T. E. Dassanayake,
Superintendent, Observatory.

METEOROLOGICAL REPORT, DECEMBER, 1948

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		In.		In.
Agalawatta	86·8	—0·6	70·7	—0·4	86	97	7·2	10·22	19	— 0·41
Anuradhapura	82·1	—1·0	71·5	+1·3	86	95	8·4	25·77	20	+18·25
Badulla	76·2	—0·6	65·3	+0·8	88	95	8·0	14·54	22	+ 3·31
Batticaloa	81·3	—0·7	74·1	+0·6	86	90	9·0	33·11	26	+16·12
Colombo	85·7	+0·3	72·2	—0·2	82	95	7·3	5·22	15	— 0·39
Diyatalawa	70·7	—1·5	60·1	+1·5	91	97	9·1	11·01	21	+ 2·94
Galle	83·7	+0·1	73·5	+0·1	85	93	8·5	9·31	18	+ 1·49
Hakgala	66·1	—1·1	57·6	+4·8	86	88	9·4	14·10	23	+ 1·09
Hambantota	84·3	—0·2	73·5	+0·5	84	93	7·8	4.06	13	— 1·55
Jaffna	81·8	—0·6	73·7	+0·7	81	88	7·9	23·30	19	+12·91
Kandy	82·6	—0·6	68·3	+1·0	82	92	8·9	11·38	22	+ 2·94
Kurunegala	85·7	—0·3	72·2	+1·5	78	90	7·5	6·91	16	+ 0·13
Lunuwila	86·4	+0·1	73·1	+1·2	80	93	6·8	3·99	10	— 0·61
Mannar	81·2	—1·6	74·9	+0·1	83	86	8·2	12·52	17	+ 4·73
Nuwara Eliya	67·4	—0·4	51·7	+3·0	85	91	8·4	9·30	20	+ 1·49
Puttalam	83·7	—1·0	72·2	+0·9	85	93	6·8	8·85	16	+ 3·30
Ratnapura	87·6	—0·3	72·3	+0·6	82	95	9·1	9·15	14	+ 0·03
Talawakele	73·4	—0·2	57·7	+1·6	80	85	6·8	6·92	19	+ 1·74
Trincomalee	81·0	—0·1	74·7	+0·1	88	88	8·0	32·28	27	+19·28

Heavy rain was experienced in the north-east of the Island in December, a large number of stations recording over 25 inches for the month, some of the totals being more than double the average. Heaviest rain occurred along the east coast and on the north-eastern slopes of the hills, Upper St. Martin's Estate receiving a total of 52·95 ins., Hendon Estate 49·20 inches, Kilinochchi Farm 44·58 inches, Lower St. Martin's Estate 44·50 inches, Dooroomadella Factory 44·47 inches, Allai Tank 42·95 inches, Pulukunavi 42·18 inches, and Valaichenai 41·76 inches.

In the south-west rainfall was generally below 15 inches while least rainfall (below 5 inches) was found in the north-west and south-east.

Excesses of over 15 inches occurred throughout the north-eastern low-country and also close to Anuradhapura, outstanding examples being 27·58 inches at Allai Tank, 26·87 inches at Pulukunavi, 26·49 inches at Mullaittivu, and 25·99 inches at Kilinochchi Tank. In the south-west rainfall was irregularly distributed on either side of average, excesses predominating. The only deficits over 3 inches were 5·51 inches at Sudupanawela, 4·37 inches at Yala, and 3·23 inches at Negombo.

On the 31st, abnormally heavy rain was experienced on the north-eastern slopes of the hills and in the North-Central Province, 58 stations recording falls over 5 inches. Rainfall around Anuradhapura was exceptionally heavy on that day, breaking previous long-period records. Seven stations around Anuradhapura received over 10 inches, the highest being 15·32 inches at Kurundankulama, 13·50 inches at Kahatagasdigiliya, 12·58 inches at Anuradhapura (previous highest fall 9·32 inches in 1891), and 12·45 inches at Mihintale (previous highest fall 7·85 inches in 1882). Altogether 110 daily falls of 5 inches or over were recorded in December.

Temperatures were generally below normal by day and above normal by night. The maximum recorded shade temperature was 92·2° at Ratnapura on the 8th, while the lowest air temperature was 43·5° at Nuwara Eliya on the 27th. Humidities were above average, and cloud amounts were in excess. Winds were north-easterly and above average strength.

D. T. E. Dassanayake,
Superintendent, Observatory.

NOTICE

All communications regarding identifications and material for identification should in future be sent direct to the Assistant in Systematic Botany, The Herbarium, Peradeniya.

BLACK BEETLE OF COCONUTS

The Regulations made under the Plant Protection Ordinance (Cap. 307) for the purpose of preventing the spread of the pest known as the Black Beetle of Coconuts are not sufficiently well known. These regulations are reproduced below for general information :—

Regulations

1. All dead coconut palms must be forthwith uprooted and either consumed with fire or kept completely submerged in water so that the beetle and all eggs and larvae thereof may be totally destroyed and that the palms may not serve as breeding places.

2. Dead coconut stems or pieces of coconut stems (except such as are used for building purposes or for bridges), or rubbish heaps or other matter, which would be likely to harbour or become breeding places for the said beetle, must not be kept or permitted to be kept on any land or premises.

3. Accumulations of dung or vegetable refuse required for manurial purposes must not be retained for a longer period than four months before application, except when stored in a covered and properly constructed manure pit.

LIST OF ACQUISITIONS TO THE LIBRARY, DEPARTMENT OF AGRICULTURE, FOR THE PERIOD OCTOBER 1, 1948, TO DECEMBER 31, 1948

BOOKS

1. Loesecke—Outlines of Food Technology.
2. Loesecke—Drying and Dehydration of Foods.
3. Spencer & Meade—Cane Sugar Handbook (8th edition).
4. Williamson, H.—The Story of a Norfolk Farm.
5. Walter, H. E.—Genetics (4th edition).
6. Percival, J.—Agricultural Botany (8th edition). (Issued to Principal, G. F. S. K.)
7. Brade-Birks—Good Soil (Issued to Principal G.F.S.K.)
8. Hutcheson, Wolf, & Kipps—Production of Field Crops (2nd edition). (Issued to P., G.F.S.)
9. Jacks & Whyte—The Rape of the Earth (Issued to P., G.F.S.)
10. Lawrence—Practical Plant Breeding (2nd edition). (Issued to P., G.F.S.)
11. Bennett—Elements of Soil Conservation. (Issued to P., G.F.S.)
12. Gustafson—Soils & Soil Management. (Issued to P., G.F.S.)
13. Gustafson—Conservation of the Soil. (Issued to P., G.F.S.)
14. Robinson—Mother Earth. (Issued to P., G.F.S.)
15. Ramiah—Rice in Madras. (Issued to P., G.F.S.)
16. Bainbridge & Menzies—Essentials of Physiology (9th edition).
17. Peters & Slyke—Quantitative Clinical Chemistry Vol 1 (2nd edition). (Issued to Chemist.)
18. Fritsch—The Structure and Reproduction of the Algae Vol I.
19. Waite—Poultry Science and Practice.
20. Cowie—Pregnancy Diagnosis Tests : A Review.
21. Phillips, R. W.—Breeding Livestock Adapted to Unfavourable Environment. (Issued to Specialist in Animal Husbandry, Production).
22. Ling, E. R.—A Textbook of Dairy Chemistry, Vol 2 (2nd edition).
23. The Dawn of Lanka's Electric Age.
24. Langdon-Davis—Measuring the Future.
25. U. S. Department of Agriculture Yearbook, 1948.
26. Lewis,W. R.—Notes on Soldering.
27. Sheat, W. G.—Propagation of Trees, Shrubs and Conifers.
28. Chinnathamby—The Palmyrah Tree.
29. Ariyanayagam, D. V.—Growth and Uptake of Nitrogen in Wheat.
30. Murneek & White—Vernalization and Photoperiodism.
31. Pearson & Harper—The World's Hunger.
32. Miller, D.—Interior Decorating. (Issued to P., G.F.S.)
33. Grange & Gibbs—Soil Erosion in New Zealand.
34. Barnes, H. F.—Gall Midges of Economic Importance, Vol III.
35. The Concise Oxford Dictionary, 3rd edition.
36. Les grands produits Agricoles.—F.A.O.
37. Morrison—Feeds and Feeding (21st edition). (Issued to Chemist).
38. Bradley, O. C.—The Topographical Anatomy of the Dog (5th edition). (Issued to the Veterinary Research Officer).

NEW PERIODICALS

1. Annales des Epiphyties et de phytogenetique.
2. Bulandshahr School of Agriculture Bulletins.
3. Bulletin analytique ministere de la France d'outre mer.
4. The Churn Bulletin.
5. Contributions de l'institute botanique de l'universite de Montreal.
6. Courrier de France.
7. Field Crop Abstracts.
8. Interagra.
9. Mauritius—Annual Reports of the Granary Department.
10. Mauritius—Reports of the Tobacco Board.
11. Metkem Journal.
12. Modern Man.
13. Napt Annual Reports.
14. North Carolina Agricultural Experiment Station Progress Reports.
15. Rubber Developments.
16. Sri Lanka.

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